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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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All Gauges and Types.
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See Advertisement page 87, July 5.

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See Advertisement page 28. 6462

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LIMITED.
See Advertisement page 47, July 9. 3402

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See Full Page Advt. page 73, June 28.

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Presses. 5195
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See Full Page Advertisement June 28.

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See's Patent Hydro-Pneumatic **Ash Ejector.**
Great saving of labour. No noise. No dust. No dirt. Ashes discharged 30 ft. clear of vessel.—Apply, F. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 42, Billiter Bldgs., Billiter St., London, E.C. Od 4035

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See Illus. Advt. last week, page 15. 5371

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For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
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Foremen, Managers and Employers connected with the Engineering Industry.
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FACULTY OF ENGINEERING.
DEAN: Associate Professor J. WEMYSS ANDERSON, M.Eng., M.Inst.C.E.
Prospectuses and full particulars of the following may be obtained on application to the REGISTRAR:—Engineering, Electrical Engineering, Civil Engineering, Naval Architecture, Marine Engineering, Engineering Design and Drawing, Refrigeration, Mathematics, Physics, Inorganic Chemistry. K 344

MANCHESTER MUNICIPAL

College of Technology (UNIVERSITY OF MANCHESTER).

Principal: J. C. M. GARNETT, M.A. (late Fellow Trin. Coll. Cam.).
Vice-Principal: R. M. WRONG, M. A. (Fellow Magdalen Coll, Oxford).

The Session 1918-1919 will open on 3rd October. Matriculation and Entrance Examinations will be held in July and September. Matriculated students may enrol for 1918-19 from 1st August, 1918, and if under 18 years of age are eligible for membership of the Officers' Training Corps.

DEGREE COURSES IN TECHNOLOGY.

The Prospectus gives particulars of the courses leading to the Manchester University degrees (B.Sc. Tech. and M.Sc.Tech.) in the Faculty of Technology, in the following Departments:—
MECHANICAL ENGINEERING (Prof. G. G. Stoney, F.R.S.).
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The College possesses extensive laboratories and workshops, equipped with full-sized modern apparatus, including machines specially constructed for demonstration and original research.
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TENDERS FOR SCOTCH CRANES.

The CROWN AGENTS FOR THE COLONIES, acting on behalf of the GOVERNMENT OF NIGERIA, invite

Tenders for the Supply

of TWO SECOND-HAND SCOTCH DERRICK CRANES, length of Jib 40 ft., to lift three tons or thereabouts.
Tenders, which must be accompanied by full particulars of the Cranes offered, but need not be on any particular form, should be delivered to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1., not later than Noon on the 23rd July, 1918, in an envelope marked "Tender for Cranes." M 36

BOROUGH OF HAMPSTEAD.

SALE OF ELECTRICAL PLANT.

The Council of this Borough invite

Tenders for the following

STEAM PLANT which they have for disposal:
Two Williams - Siemens Steam Alternators, 200 Kw. each.
One Ferranti Steam Alternator, 250 Kw.
One Ferranti Steam Alternator, 300 Kw.
All single phase, 90 periods, 2000 volts, for a working steam pressure of 160 lbs.
Also three Feed-Water Heaters with a quantity of H.P. steam and exhaust piping and valves.
The plant may be inspected by appointment, and Tender Forms and Conditions of Sale obtained upon application to the CHIEF ENGINEER and MANAGER, Electricity Works, Lithos Road, London, N.W. 3.
Tenders endorsed "Tender for Steam Plant" to be delivered at my office not later than Ten a.m. Friday, July 19th next.

By Order,
ARTHUR P. JOHNSON,
Town Clerk.

Town Hall, Haverstock Hill, N.W. 3.
July, 1918. M 64

CITY OF BELFAST.

ELECTRICITY DEPARTMENT.

The Belfast Corporation invite

Tenders for the Manufacture,

DELIVERY and ERECTION in Belfast of the undermentioned PLANT, viz.:—
SECTION "A."
(a) Two 6,600 Kw. Turbo-Alternators, &c.
(b) One 500 Kw. Turbo-Generator, &c.
(c) One 30 Kw. Balancer-Booster, &c.
SECTION "B."
(a) Four 48,000 lb. per hour Water Tube Boilers, &c.
(b) Four Fuel Economisers, &c.
(c) Two Steel Chimneys, with Fans, &c.
SECTION "C."
Two Electrically-driven Boiler Feed Pumps, &c.
SECTION "D."
Accumulators.
SECTION "E."
Three 500 Kw. and five 1,000 Kw. Rotary Converters, with Transformers, &c.
SECTION "F."
Two 250 K.V.A., two 350 K.V.A., and six 1,250 K.V.A. Static Transformers.
Tenders will be considered for either of the main sections or for either of the sub-sections.
The specifications and other particulars may be obtained on application either to Messrs. PREECE, CARDEW, SNELL & RIDER, 6, Queen Anne's Gate, Westminster, S.W. 1, or to Mr. T. W. BLOXAM, M.I.E.E., City Electrical Engineer, Belfast.
Tenders, upon the presented forms, must be lodged in the Town Clerk's Office, City Hall, Belfast, not later than 16th August, 1918.
The lowest or any tender will not necessarily be accepted.
An official receipt must be obtained for every Tender delivered by hand. Tenders sent by post must be registered.

R. MEYER,
Town Clerk. M 25

APPOINTMENTS OPEN.

KENT EDUCATION COMMITTEE.

The following Teachers are

REQUIRED in SEPTEMBER:—
JUNIOR TECHNICAL SCHOOL, GRAVESEND.
Assistant Master for Metal Work and Machine Drawing. Workshop experience desirable. Subsidiary subject, Engineering Science. Initial salary, £180 to £200, according to qualifications and experience.
Applications should be sent to the HEAD MASTER, Junior Technical School, Gravesend.
SCHOOL OF ART, BECKENHAM.
(Preparatory Department).
An Instructor for Metal and Woodwork. Practical man desired. Suitable post for a discharged soldier. Initial salary, £180 to £200, according to qualifications and experience.
Applications, giving particulars of age, experience, salary required, etc., to be sent to the Local SECRETARY, Council Offices, Beckenham, on or before Wednesday, the 24th July.
E. SALTER DAVIES,
Director of Education.
July, 1918. M 61

Teacher.—Wanted, a Whole-

Time TEACHER of MATHEMATICS as temporary war substitute in the Junior Technical School, at the L.C.C. School of Engineering and Navigation, High Street, Poplar, E. Preference will be given to a person having engineering experience. Salary at rate of £200 to £250 a year, according to qualifications.
Apply to the EDUCATION OFFICER (T.I), Education Offices, Victoria Embankment, W.C. 2. (Stamped addressed foolscap envelope necessary.) A form giving particulars will then be sent. Form must be returned by Eleven a.m. on Monday, 15th July, 1918. Canvassing disqualifies. M 39

PORTSMOUTH WATERWORKS COMPANY.

The above-named Company requires the

Services as early as possible

of a RESIDENT WORKS SUPERINTENDENT to take permanent charge (under the Engineer and General Manager) of a large portion of their Works and District, comprising Pumping Machinery ("Worthington" and "Beams,") Filter Beds, Reservoirs, Springs, Incidental Works and Properties.
The Applicant appointed must be well qualified to carry out the duties of the appointment, skilled and tactful in the management of men, of whom he will usually have about fifty under his charge.
Salary £300 per annum, with good house and garden, free of rent and rates.
Applications, stating age and experience, accompanied by testimonials or references (enclosed in envelope marked "SUPERINTENDENT," and stating the earliest date at which the candidate can take up his duties, to be addressed to The Chairman, Portsmouth Waterworks Company, and delivered not later than mid-day on Wednesday, the 24th inst.
HERBERT ASHLEY,
M. Inst., C.E., M.I. Mech. E.
Engineer & General Manager.
Commercial Road, Portsmouth.
July 3rd, 1918. M 2

MINISTRY OF MUNITIONS.

DEPARTMENT OF MECHANICAL TRANSPORT.

Technical Assistant

(Professional) REQUIRED, with a sound knowledge of Engineering Workshop Practice, within Newall limits, Metallurgy and Industrial Chemistry. Some Drawing Office experience desirable.—Apply, giving details of experience, stating age, salary required, and forwarding copies of diplomas and recent testimonials, to the DIRECTOR OF MECHANICAL TRANSPORT, 1, Grosvenor Place, S.W. 1. M 71

Assistant Railway Tele-

GRAPH ENGINEER REQUIRED for the CEYLON GOVERNMENT RAILWAY, for two years' service, with possible extension. Salary £400 a year for first year, and £500 a year thereafter. Free passages.
Candidates, who must be qualified electrical engineers with a thorough knowledge of railway telegraphs and Tyer's Tablet System and acquaintance with telephony, should apply, at once, by letter, giving full details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1. M 89

Secretary Required for Com-

pany engaged in Motor manufacturing and offering good prospects. Applicant must be a C.A. and have the highest references and preferably had experience in Motor or Engineering business.—Apply giving full details of experience, age and salary required, to M 14, Offices of ENGINEERING.

Wanted Steel Works Chemist

to take charge of Steel Melting with a 30-cwt. Electric Furnace. No one at present on Government Work will be engaged. Apply to your nearest Employment Exchange, mentioning this Journal and No. A5668. M 44

Analytical Chemists.—Assis-

TANTS REQUIRED, over 23 or ineligible for Army. Experienced analysts. Steel works experience preferred but not essential. No person already employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, quoting reference No. A 5611. L 948

TO INVALIDED OFFICERS AND SOLDIERS.

The following Vacancies

now exist in:—

Colony	Appointment	Salary	(a) Duty Allowance (s) War Bonus (see note below)	
Federated Malay States	Deputy Stores Supdt. (Rly.)	£320-15-410	(A)	£80
,, ,,	Asst. Loco. Supdt.	£360-15-480	(A)	£75
,, ,,	Asst. Telegraph Engineer (Rly.)	£360-15-480	(A)	£75
,, ,,	Asst. Telegraph Engineers	£360-5!-480	(A)	£75
,, ,,	Asst. Engnrs. P.W.D.	£360-15-480	(A)	£75
,, ,,	Asst. Electrical Engnr.	£380-10-390	(A)	£78
,, ,,	Asst. Engrs. (Railway)	£380	(A)	£75
,, ,,	Survey Map Draughtsman	£300-10-400	(A)	£80
Straits	Asst. Engnr. (Civil and Municipal)	£360-15-480	(A)	£75
Ceylon	Architect	£300-25-350		
Trinidad	Institute Sec. & Mathema. tical Instr.	£200		
Gold Coast	Loco. Draughtsman & Instr. (Railway)	£350-10-400	(B)	£80
,, ,,	Asst. Telegh. Engineer	£350-10-400	(B)	£60
Nigeria	Asst. Loco. Supdt.	£300-10-350	(B)	£60
,,	Asst. Accountants and Storekeepers (Railway & Colliery)	£300-10-350	(B)	£60
Sierra Leone	Rlwy. Traffic Officer	£225-10-275	(B)	£36
Uganda	Sub Telegrh. Engineer	£300-10-300		

Free first-class passages are provided, and free quarters. Duty allowance and war bonus, where shown above, are paid only while actually on service, and war bonus only to those supporting dependents at home.
TECHNICAL TRAINING AND EXPERIENCE ARE ESSENTIAL.
Candidates should apply by letter, stating briefly their experience and the physical disability for which discharged from the Army, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1. M 72

Wanted, Manager for Foundry

and Rolling Plant for Light Alloys, in South of England. Must have previous experience in the rolling and manufacture of alloys. No one engaged on Government work need apply, unless with consent of present employers.—Address, stating age, experience and salary required, M 48, Offices of ENGINEERING.

Works Manager Wanted by

large and old established General Engineering Firm in North of England.
Must be experienced in up-to-date methods of production, and have good organizing abilities with actual experience in dilution of labour.
No one on Government work will be engaged.
Address, giving full particulars of experience, age, and salary expected, M 64, Offices of ENGINEERING.

Works Manager Required

for 18-pdr. shell shops, within ten miles of Charing Cross. Previous experience of this munition essential.—Address, stating qualifications and salary required, M 50, Offices of ENGINEERING.

Works Organiser Required

to advise Management or organise growing business. Patent Specialities, 80 hands. Capital available.—State record and references to M 15, Offices of ENGINEERING.

Rate Fixer.—First-class Tool-

room Rate Fixer REQUIRED, by a firm in the Midlands engaged on Aero Engine production. Applicants must have had a tool room experience of high-class work. No person already engaged on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5503. L 903

Representative for France.—

A well-known London Firm REQUIRES the SERVICES of an Experienced ENGINEER. One with some commercial experience preferred and who is able to correspond and speak English, to take charge of the Paris Office. The position will be permanent to the right man and good prospects are offered.
Write, in strict confidence, giving experience, age, and some idea of remuneration required to Z.L. 375, DEACONS Advertising Office, Leadenhall Street, E.C. 3. M 66

Foreman Engineer Wanted,

accustomed to the Charge of Heavy Machine Tools, Fitting and Erecting of Rolling Mill Machinery. No person already on Government work will be engaged.—Apply, stating age, wages and experience, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5617. L 963

Draughtsmen Required

by an Admiralty Department.
(a) Those with good general mechanical engineering experience.
(b) With good general electrical experience.
In both cases must be capable of preparing full working drawings, from rough designs and sketches.
Address, giving full details of training and experience, age, salary required, and when at liberty, M 73, Offices of ENGINEERING.

MINISTRY OF MUNITIONS.

DEPARTMENT OF MECHANICAL TRANSPORT.

Mechanical Draughts-

MEN REQUIRED, with a sound practical knowledge of Engine, Chassis and Gearbox Design for cars, lorries and caterpillar tractors—petrol and steam driven.—Apply, giving details of experience, stating age, salary required and forwarding copies of recent testimonials, to the DIRECTOR OF MECHANICAL TRANSPORT, 1, Grosvenor Place, S.W. 1. No one engaged on Government work or resident more than ten miles away will be engaged. M 70

Rising Firm of Engineers

and Contractors for Reinforced Concrete Constructions with large interests in Concrete Shipbuilding OFFER POST as CHIEF ENGINEER for their Westminster Drawing Office to competent expert Engineer with several years practical experience. No one at present on Government work or resident more than 10 miles away will be engaged.—Address, stating age, experience, and salary required to L 999, Offices of ENGINEERING.

First-class Draughtsmen

REQUIRED (also one Junior Draughtsman), with experience of Diesel or Semi-Diesel Marine Engines, and their accessories. No one on Government work will be engaged. State age, experience, and salary required.—Apply your nearest EMPLOYMENT EXCHANGE, quoting No. A 5687. M 76

Several Experienced Mechani-

cal DRAUGHTSMEN REQUIRED by a Naval Establishment on the South Coast. Men with experience in designing small interchangeable parts preferred. No one already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, quoting No. A 5654. M 88

Mechanical Engineering and

Maintenance DRAUGHTSMAN WANTED, with ability to take out stresses and strains, for large engineering works in Manchester district. No one already on Government work will be considered.—Apply, with particulars of age, experience, and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 5680. M 85

Wanted, Experienced and

capable Jig and Tool DRAUGHTSMAN, preferably with experience of Motor Vehicle Manufacture. London district. No person already on Government work will be engaged.—Apply, stating age, salary and full particulars of experience, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 3029. L 802

Draughtsmen Required in

important munition works. Those accustomed to furnace design preferred. No one on Government work or living more than 10 miles away will be engaged. State experience, age and salary required.—Apply to BOX 134, Advertising Offices, 84, Queen Victoria Street, London, E.C. 4. L 934

Tracers Required in Important

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COAL SAVING BY THE SCIENTIFIC CONTROL OF STEAM BOILER PLANTS.

By D. BROWNLIE, B.Sc.Hons.(Lond.), F.C.S.

SOME time ago (April 14 and 28, 1916) the author, in conjunction with Mr. H. Green, wrote an article for the columns of this paper entitled "The Running of Boiler Plants and National Economy," in which was given average figures for the exact working performance of 100 typical steam boiler plants as working in the industries of this country, covering the period 1913, 1914 and 1915.

The author has been associated for about ten years with the investigation on scientific lines of the working of every description of steam boiler plant, and in the present article it is proposed to give the average figures for 250 typical steam boiler plants (covering the period from 1910 to the present time), with the object of supplying further accurate data as to the tremendous national economy that can be effected by the adoption of scientific methods in the boiler-house.

The question of coal economy is of absolutely vital importance to the nation, and we appear to be drifting into a very serious state of affairs, the reason being our usual lack of the application of scientific methods in industry. We are, however, at last beginning to get some figures and information on the coal question.

According to the recent interim report on electric power supply in Great Britain of the Reconstruction Committee (Coal Conservation Sub-Committee), Ministry of Reconstruction, the total annual output of coal of all the mines of the United Kingdom before the war (taking 1913 as typical) was approximately 287,000,000 tons, of which 189,000,000 tons were consumed at home as follows :—

	Tons.
1. Railways...	15,000,000
2. Coasting steamers	2,500,000
3. Factories	60,000,000
4. Mines	20,500,000
5. Iron and steel industries ...	31,000,000
6. Other metals and minerals ...	1,250,000
7. Brickworks, potteries, glass works, chemical works ...	5,750,000
8. Gas works	18,000,000
9. Domestic	35,000,000
	189,000,000

At the present time (taking the returns for the year 1917) the total output is only 248,500,000 tons, representing a very serious decrease.

Coal economy is urgently required at once, first of all as an immediate war measure. As more and more men are taken out of the mines for the army, 100,000 being required immediately, matters as regards coal output from the mines will get worse and worse.

Large coal consumers are having their supply curtailed, and in some cases even munition works are having difficulty in obtaining the necessary amount of coal to maintain their output. The appeals to the public to economise in coal and restrict themselves to a bare sufficiency in the use of gas and electricity are becoming more and more insistent, and we now understand that the whole country will have to go on coal rations.

At the same time we have to maintain the vast exports of coal so vital to our allies, whilst the average price at the pit-head to-day is probably about 12*s.* per ton, as compared with, say, 5*s.* only a few years ago. Coal economy is no less urgently required as part of a great national scheme of reorganisation, particularly in the direction of improved scientific methods in industry, that are essential to our progress as a nation.

Turning now to one section of the question, the burning of coal in steam boilers for the generation of steam, the loss in this direction because of lack of scientific methods is hardly realised and, apart from the national point of view, offers to the individual firm a means of most substantial economy in running expenses.

As we have already seen, the total coal consumption of the whole country in normal times is approximately 189,000,000 tons, and after deducting the amount used for railways, coasting steamers, gas works and domestic purposes, we are left with an annual consumption of 118,500,000 tons. Some proportion of this amount is, of course, used for blast furnaces, chemical processes, kilns, producer and other gas plants (apart from gas works), &c. According to the recent report, already mentioned, of the Reconstruction Committee, about 80,000,000 tons of coal are used for power production only, inclusive of railways. Deducting 15,000,000 tons for railways leaves us with the figure of 65,000,000 tons, of which, according to the report, about 90 per cent. is used for power produced by steam raising, corresponding, therefore, to 58,500,000 tons. But in addition to power there is an enormous amount of steam used for heating and general technical processes. Thus in industries like dyeing, bleaching, calico printing, tanning, hat manufacture, brewing, the chemical trades, &c., much more steam is used in this way than for power production.

Also in very many other industries a considerable quantity of steam is used even although the amount may be less than that used for power. It is not possible to find out what is the exact amount of coal used for the production of steam for purposes other than power, there being for example no statistics available showing the number of steam boilers at work in Great Britain.

The author proposes therefore to assume, until further information can be obtained by a proper engineering census of the country, that the total amount of coal used for steam generation in the United Kingdom is between 75,000,000 tons and 100,000,000 tons per annum (being 60,000,000 tons to 70,000,000 tons for power production and 15,000,000 tons to 30,000,000 tons for purposes other than power), corresponding to 40 per cent. to 53 per cent. of the total coal used.

The author is of the opinion that the 250 boiler plants to be dealt with in the present article are really representative of all the boiler plants of the country, and that the results of such a very large number of exhaustive scientific investigations carried on continuously during the last eight years will enable us to judge with very considerable accuracy as to the saving that can be obtained by improving the present methods of burning 75,000,000 tons to 100,000,000 tons of coal per annum for steam generation. These 250 plants are situated in England, Ireland, Scotland and Wales, and the following industries are represented :—

Bleaching.	Hat manufacture.
Brewing.	Hosiery manufacture.
Calico printing.	Hospitals.
Carpet manufacture.	Hotels.
Chemical (general).	Lace manufacture.
Collieries.	Laundry.
Cotton manufacture.	Leather manufacture.
Dyeing.	Linen manufacture.
Dyeing and cleaning.	Paper manufacture.
Electric power stations.	Potteries.
Engineering.	Soap manufacture.
Explosives.	Steel manufacturer.
Flour milling.	Woollen manufacture.
Food products.	

They comprise all sizes of plants with annual coal bills of from 750 tons to 70,000 tons, whilst the average working pressure varied from 12 lb. to 200 lb. per square inch.

The fuels used are of every possible description, from the highest qualities of washed nuts, beans, peas and fine slack, and large and small screened coal, down to inferior fuels of all qualities including refuse coal mixed with shale, pit sweepings, washer settlings, &c., as well as coke and coke breeze.

As a further support for the claim that these 250 steam boiler plants are typical of the whole country the author has, during the past ten years, inspected, without testing, probably several thousand boiler plants, and finds that these are all being worked on more or less the same general lines.

Below are given the average working figures of the 250 plants, obtained by adding together the essential figures of each separate plant and taking an average :—

Average of 250 Typical Boiler Plants.

(A) *Working Day's Test* :—	
Type of boiler	... "Lancashire."*
Number of boilers ...	... 4†
Grate area	... 152·6 sq. ft.
Duration of test ...	... 9·43 hours
Price of fuel used ...	... 14*s.* 6*d.* per ton delivered
Amount of fuel used ...	... 30,131·72 lb.
Analysis of fuel used :	
British thermal units	... 11,822
Ash	... 11·5 per cent.
Fuel burnt per boiler per hour...	798·8 lb.
Fuel burnt per square foot of grate area per hour	20·9 lb.
Water evaporated ...	197,776·0 lb.
Water evaporated per boiler per hour	5,243 lb.
Water evaporated per square foot of grate area per hour ...	137·4 lb.
Water evaporated per pound of fuel	6·56 lb.
Equivalent evaporation from and at 212 deg. F., per pound of fuel	7·46 lb.
Equivalent evaporation from and at 212 deg. F., per 1,000,000 British thermal units	631·0 lb.
Temperature of feed water before economisers	116 deg. F.
Temperature of feed water after economisers	193 deg. F.
Percentage of fuel bill saved by economisers	7·1 per cent.
Draught in side flue	0·40 in W.G.
Draught in main flue at exit of economisers or chimney base	0·80 in W.G.
Temperature of flue gases before economisers	598 deg. F.
Temperature of flue gases after economisers	478 deg. F.
Percentage of CO_2 in flue gases from side flue of boilers by means of combustion recorder	7·6 per cent.
Steam pressure :	
Pounds per square inch (gauge)	89
Pounds per square inch (absolute)	104
Temperature of saturation of steam	330·5 deg. F.
Temperature of superheated steam	346·5 deg. F.
Steam or power used as auxiliary to the production of steam...	2·4 per cent.
Thermal efficiency :	
(A) Net working efficiency of plant complete, after deducting 2·4 per cent. steam or power used as auxiliary to the production of steam ...	...60·09 per cent.
(B) Boilers only ...	...56·71 per cent.
(C) Economisers only	... 4·35 per cent.
(D) Superheaters only	... 0·51 per cent.
Cost in fuel to evaporate 1,000 gallons of water :	
(*a*) 14*s.* 6*d.* (average price)...	118·3*d.*
(*b*) 20*s.* (to-day's price) ...	163·2*d.*
(B) *Long Check Test* :—	
(One week of 7 days.)	
Duration...	167·5 hours
Price of fuel used ...	... 14*s.* 6*d.* per ton delivered
Amount of fuel used	128·25 tons
Water evaporated	184,435·0 galls.
Water evaporated per pound of fuel	6·42 lb.
Cost in fuel to evaporate 1,000 gallons of water :	
(*a*) Fuel at 14*s.* 6*d.* (average price)	120·9*d.*
(*b*) Fuel at 20*s.* (to-day's price)	166·9*d.*

* See paragraph A on page 26, middle column.
† See paragraph B on page 26, middle column.

METHOD OF CARRYING OUT THE TESTS.

Before discussing the results a short description may first be given of the methods used in carrying out the investigation of the working of the plants in each case. A detailed test of the plant was made for one working day, and a further test of one week was also carried out as a check on the figures for the fuel used and the water evaporated, and to ascertain the weekly running conditions, including all week-end losses due to stoppage of plant, &c. The object of the test was to find out the exact normal everyday working conditions of the plant, particularly as regards efficiency and the cost in coal for the production of unit of steam (evaporation of 1,000 gallons of water), so that a scheme of reorganisation could be devised for the more economical production of steam. In every case the boiler-house staff worked the plant as usual, and at the end of the tests the water-level in the boilers and the general conditions of the fires was the same as at the commencement. Taking the various items which require some explanation in detail :—

1. *Weight of Fuel Used.*—This was determined in the usual various ways, depending on the circumstances of the case, from weighing the fuel in barrows or bags, to weighing carts and railway trucks direct.

2. *Analysis of Fuel.*—The sampling was carried

out with the greatest care. Samples were taken every half-hour by the clock, and also every hour. At the end of the trial the hourly and half-hourly samples were broken up, thoroughly mixed, quartered, and so on as usual, several pounds being finally taken in sealed tins for analysis. There was thus obtained two entirely independent samples of the same fuel.

These two samples were analysed separately, and the average figures taken. If more than one quality of fuel was used, each separate quality had two independent samples taken, as already described. Further, during the week's trial a sample of the fuel was taken each hour, the samples mixed, and an average sample for each day analysed, making, for one quality of fuel only, two samples on the day's test and seven for the week. By this means a very good average of the fuel was obtained. As regards the analysis, the heating value was determined by means of an oxygen bomb calorimeter ("Mahler-Donkin"). The bomb type of calorimeter is, of course, acknowledged to be the standard scientific instrument for accurate heat determination, and the method consists in burning the damp fuel (as fired) in a platinum-lined, gunmetal bomb in oxygen at about 450 lb. pressure per square inch. The ignition is made inside the bomb by means of a fine platinum wire heated by outside electric contact. The bomb is covered with a known amount of water at a known temperature, and, after ignition, the rise in temperature observed with a thermometer graduated to $\frac{1}{100}$ deg. C. As the combustion is instantaneous and totally enclosed, the heating value is obtained direct, without any corrections being required. Further, the combustion is always complete, which is not the case with many inferior types of calorimeter. The amount of ash was determined by complete combustion in the muffle furnace, so that the figure given for the percentage of ash represents the real non-combustible matter. Ashes from a boiler fire-hole, of course, almost always contain some combustible matter.

3. *Water Evaporated.*—Various methods were used, depending on circumstances, to measure the water evaporated, but, generally, the method adopted was the use of a well-known make of pressure-type hot water meter calibrated before each test, and working between the boiler-feed pump and the economisers. The old method of weighing the water direct in tanks, which was sometimes used, is, of course, very cumbersome, and almost impossible for regular weekly recording, such as is necessary on a properly-organised boiler plant. Some form of water meter is therefore essential. Which ever type is adopted, the author strongly recommends the additional installation of a calibrated tank of, say, 500 gallons to 1,000 gallons capacity, so that the accuracy of the meter in use can be checked at any time.

4. *Analysis of Feed Water.*—Samples of the feed water passing through the water meter were taken every half-hour during the day's test, and a good average obtained in this way. The samples were analysed by the Wanklyn soap-test method before and after boiling, giving the permanent and temporary hardness. The soap test, although generally regarded as not very accurate by chemists, is extremely convenient for this class of work. In exceptional cases a full scientific analysis of the feed water was carried out, giving the amount of total solids, calcium and magnesium carbonates and bicarbonates, alkalinity, &c.

5. *Temperature of Feed Water.*—On the day's test, the temperature of the feed water, before and after the economisers, was taken every half-hour, or oftener if the variation was considerable. For this purpose calibrated thermometers were used as economiser thermometers are rarely correct after months of usage.

6. *Draught Measurement.*—On the day's test, this was taken every half-hour in the side flues, and either in the main flue after the economisers or in the chimney base. A ½-in. wrought-iron pipe was inserted into the middle of the flues, and the draught taken with an ordinary draught gauge of the glass U-tube type.

7. *Temperature of the Flue Gases.*—For this determination a well-known make of pyrometer was used of the thermo-electric type, with platinum-iridium and platinum junction, in a porcelain tube enclosed in a steel tube, and connected through coils of calibrated wire to a voltmeter graduated direct from 212 deg. F. to 1,500 deg. F., in divisions of 20 deg. The instrument was arranged with a two-way switch, two coils of wire, and pyrometers in the flue before and after the economiser, so that the two readings could be read practically simultaneously. Before each test the instrument was calibrated by means of the vapour of some substance with a high boiling-point in a special form of iron condenser for the purpose. As usual, on the day's test, readings were taken every half-hour.

8. *Percentage of CO_2 in Flue Gases.*—In each case some reputable make of combustion recorder was fitted on the plant, and the percentage of CO_2 recorded at the rate of about 20 analyses per hour on a chart along with the time of the analysis. One week's run was taken in this way in each case. The samples of gas were taken from the side flues or downtake of each boiler in rotation, allowing, as a rule, about 12 hours (say 240 analyses) on each boiler, so that at the end of a week a very good average was obtained. At the present time the author is using a much improved type of combustion recorder, which will give, if necessary, two months' continuous record, day and night, on one chart, at the rate of 20 analyses an hour. At the same time the composition of the flue gases was determined by means of the "Orsat" apparatus. This was done more generally as a check on the combustion recorder, and usually about 6 to 10 analyses were taken during the day's test.

9. *Steam Pressure.*—On the day's test, the steam pressure was taken every half-hour, or oftener if there was a considerable fluctuation.

10. *Temperature of Superheated Steam.*—On the day's test, the temperature of the superheated steam was taken every half-hour with a calibrated mercury thermometer. Like economiser thermometers, the thermometers in general use with superheaters are seldom very accurate.

11. *Auxiliary Steam.*—With regard to the steam or power used as an auxiliary to the production of steam, in the case of an engine the indicated horse-power of the engine was taken, and from the type of engine used a very good idea was obtained of the steam used. Thus, for the ordinary enclosed, forced-lubrication, high-speed engine in use for driving forced or induced-draught fans, an average figure is 35 lb. of steam per indicated horse-power. In the case of a motor drive the power used is, of course, very easily determined. The difficulty is in connection with steam used in the form of steam jets, either under or over the fire-bars.

The author has devised an apparatus for the purpose of estimating the amount of steam issuing from nozzles, consisting of an enclosed cylinder connected with a long condensing coil. In determining the steam used, the steam pipe and nozzles, or heavy casting with series of small holes, or other apparatus used, is placed bodily in the enclosed cylinder and coupled up in exactly the same manner as when under the fire-bars. The steam passes through the cylinder and the coils, which are immersed in cooling water and open to the air at the end, and the steam used over a period of several hours weighed direct as condensed water. This apparatus is found to be very simple and convenient, and gives absolutely accurate results.

Detailed Analysis of the Results of the 250 Tests.

(A) *Type of Boiler.*—The 250 plants had a total of 1,000 boilers, comprising 935 "Lancashire" boilers, 36 modern "tubular" boilers, 17 "egg-ended" boilers, 6 "Cornish" boilers, 1 "marine" boiler, 2 "vertical" boilers, and 3 "patent" boilers difficult to classify. It would be most interesting to know the exact number of each type of steam boiler at work in the country, although there is no doubt that the chief type of boiler in use is the "Lancashire."

(B) *Number of Boilers per Plant.*—As already seen, the total number of boilers included in the whole 250 plants was 1,000, giving therefore an average of four boilers per plant. The plants varied in size from one small "vertical" boiler to 35 "Lancashire" boilers, 30 ft. by 8 ft.

(C) *Grate Area.*—The total grate area of the 250 boilers was 38,158·6 sq. ft., corresponding to 152·6 sq. ft. per plant, or 38·1 sq. ft. per boiler, which, on the assumption that all the boilers were "Lancashire," would give an average grate-area length of approximately 6 ft.

(D) *Price of Fuel Used.*—The average on the whole 250 plants from 1910 to the present time works out at 14*s.* 6*d.* per ton delivered.

In the previous paper, giving 100 plants from 1913 to 1915, the average price was 12*s.* 2*d.*, but the general price of fuel has risen considerably since the average period 1913–15, and to-day the average price of fuel is probably approximately 20*s.* per ton for the whole country. It is, of course, very difficult to arrive at a true average because of the great variation in this respect between different localities.

(E) *Amount of Fuel Used.*—The average figure shows 20·9 lb. of fuel per square foot of grate area per hour, referring, of course, to the average amount burnt per hour per working day, and not to the amount for any particular hour. This figure is considerably below what is possible on a boiler plant run on modern lines, which would give something like 25 lb. to 30 lb. per square foot grate area per hour with the average quality of fuel. The boiler plants of the country are working under very easy conditions in this respect, and much more fuel could be burnt per boiler. Figures for fuel consumption depend very largely on the quality of the fuel. Thus a good quality washed coal of, say, 13,000 British thermal units and 7 per cent. to 8 per cent. ash could easily be burnt economically at the rate of 35 lb. per square foot per hour, whereas purely refuse coals would only give about 15 lb. Coke of good quality can be burnt at the rate of 22 lb. per square foot grate area per hour and coke breeze about 15 lb.

It will be understood that a boiler plant can be worked just as efficiently with a low fuel consumption as with one of normal figures, but the trouble with many boiler plants is that the increased fuel consumption is required to give more steam but cannot be obtained because of lack of scientific methods.

Taking the average amount of fuel burnt per boiler per week from the long check test as 32 tons, equal to, say, 1,650 tons per annum, the annual consumption of 75,000,000 tons to 100,000,000 tons gives us the figure of 45,000 to 60,000 steam boilers at work in Great Britain calculated in terms of averaged-sized "Lancashire" boilers.

(F) *Analysis of Fuel Used.*—In only four cases was the fuel analysed in an accurate manner and purchased scientifically, guided by the determination of the heating value. In certainly over 90 per cent. of cases the fuel was purchased in a general rule-of-thumb manner, without any accurate knowledge of its real value. It is perhaps hardly necessary to point out that a firm that buys fuel buys heat; that, other things being equal, the fuel that contains the most heat is the best value for the money, and that it is impossible to get the best results by buying and using fuel completely in the dark as to its heating value. The author is of the opinion that certainly not 5 per cent. of steam users buy their fuel on scientific lines. These remarks hardly, of course, apply to-day because of the abnormal conditions due to the war and the fact that the fuel supply is so restricted that the consumer is glad to get hold of any kind of fuel, but the point is that previous to the war these remarks hold good, and as far as can be seen will also hold good when the war is over unless we alter our methods. It would hardly be possible to give a better example of the general lack of scientific methods in vogue in our industries generally than that of the buying and selling of fuel.

Taking the estimate of 75,000,000 tons to 100,000,000 tons of coal as the annual consumption for steam-raising purposes only, this is worth at the pit head to-day probably about 12*s.* per ton or, say, 45,000,000*l.* to 60,000,000*l.* per annum, whilst to the fuel buyer the average price is to-day probably about 20*s.* per ton or, say, 75,000,000*l.* to 100,000,000*l.* per annum. Certainly well over 50,000,000*l.* worth of fuel per annum is purchased for steam-raising purposes by methods which would be ridiculed in most other forms of buying and selling.

The author's experience is that in normal times the average firm could save 7 per cent. to 10 per cent. of the fuel bill alone by buying on scientific lines—that is, by buying the coal or other fuel which was the best value under the conditions of the given steam-generating plant.

(G) *Quality of Fuel.*—The average for the 250 plants shows 11,822 British thermal units and 11·5 per cent. ash, which includes almost every description of coal and coke varying in quality from 7,000 British thermal units to 14,000 British thermal units.

The author has had the most exceptional opportunity of judging the qualities of fuel in general use since about 1910 and is of the opinion that there has been a great deterioration in the quality of coal and coke since the war started and that at the present time the average heating value is probably at least 10 per cent. inferior to pre-war days. Thus in the original paper giving the results of 100 tests, from 1913–15, the average figure for the fuel analysis was 12,680 British thermal units and 9·3 per cent. ash.

As regards coke, a good average sample of coke shows about 12,000 British thermal units to 12,500 British thermal units with 12 per cent. ash, whilst a good sample of coke breeze shows 9,000 British thermal units to 10,000 British thermal units and 15 per cent. to 20 per cent. ash. The great trouble with coke and coke breeze is the amount of moisture contained in them. Good samples should only contain about 5 per cent. and certainly not over 8 per cent. Many samples, however, contain regularly 20 per cent., which is a most serious matter from the point of view of economy. Thus coke is being used to-day as fuel for steam raising costing 35*s.* per ton and with the following analysis: 10,000 British thermal units, 15·5 per cent. ash, and 14·5 per cent. water.

(H) *Method of Firing.*—In 190 cases (76 per cent.) hand firing was in use, with an average net working efficiency of 57·8 per cent., as against 60 cases (24 per cent.) of mechanical firing with an average net working efficiency of 61·4 per cent., representing eight different makes of mechanical stokers.

There is a very considerable conflict of opinion among steam users as to the advantages or otherwise of mechanical firing as compared with hand firing. As seen from the figures, 190 cases of hand firing are giving slightly inferior results to 60 cases of mechanical firing. One factor to be taken into account is the cost of upkeep of mechanical stokers, but taking an average for the whole country this increased cost is probably equal to the saving in labour of hand firing. It is not realised how bad is the general working performance of the mechanically fired steam boiler plants, and we are so used to reading the remarkable results of boiler trials in catalogues and advertisements of some mechanical stoker firms that an average efficiency of 61·4 per cent. under actual working conditions comes somewhat as a shock.

Taking boiler plants generally it is very difficult to decide as to whether hand or mechanical firing is preferable. In the case of "tubular" boilers with large grate areas mechanical firing is undoubtedly the best, and very good results can be obtained provided that the mechanical stokers have constant skilled attention and supervision. In the case of "Lancashire," "Cornish," "marine," and similar types of boiler with the ordinary narrow grate the matter is very complicated, and it is more difficult to get good results with mechanical firing as compared with "tubular" boilers.

Obviously a great many factors enter into the case, such as quality of fuel, amount of steam required, and whether the demand is fluctuating or not, the quality of the supervision, and so on. A given type of mechanical stoker may work well under certain conditions and very badly under certain other conditions.

One can only say that with both hand and mechanical firing 75 per cent. to 82½ per cent. efficiency can be maintained, and a very careful examination of the general working conditions of the plant must be made before deciding for hand or mechanical firing, and if the latter, which type of stoker. The usual practice is to instal mechanical stokers or pull them off again in the most rule-of-thumb manner, both mechanically fired and hand-fired plants receiving very little scientific attention and supervision.

(I) *Measurement of Boiler-Feed Water.*—Out of the 250 plants, in 25 cases only was there any apparatus installed on the plant for determining regularly the water evaporated—that is, the amount of the steam produced. Further, out of the 25 cases, several of the water meters in use were certainly not accurate.

A boiler plant is, of course, a little factory in itself, in which the finished product is steam, and unless there is some form of water-measuring apparatus at work to regularly check the performance of the plant, there is bound to be some loss. How much, is merely a matter of accident. The author is of the opinion that not 5 per cent. of the boiler plants of the country are fitted with accurate water-measuring apparatus in regular use.

(J) *Amount of Water Evaporated.*—The average figures for the 250 plants show approximately an evaporation of 524 gallons per boiler per hour. Converting this into "Lancashire" boilers and calculating for a standard size of 30 ft. by 8 ft., the average evaporation is slightly under 600 gallons per boiler per hour. These figures, of course, refer to the average evaporation per hour per working day, and not to the evaporation for any particular hour. Although the evaporation of a boiler naturally depends on the quality of the coal used, there is no doubt whatever that the boiler plants of the country generally are evaporating much less water than would be possible under proper scientific methods of control. Probably all the steam produced in Great Britain to-day could be obtained much more economically with 25 per cent. less boilers.

On the previous rough calculation of 45,000 to 60,000 boilers taken as standard "Lancashire" boilers at work, this would correspond to, say, 11,000 to 15,000 boilers being made available, an interesting point in the present shortage of boilers and steel generally.

The author has reorganised many boiler plants and doubled the evaporation per boiler per hour, which means that with cases of very large plants of 30 "Lancashire" boilers or over no less than 15 or more boilers could be shut down in one establishment alone.

There are hundreds of boiler plants at work which are always more or less short of steam, and in which, by a very moderate amount of re-organisation, the output of steam could be considerably increased, making a great difference in the efficiency of the general running of the factory. Thus, in a well-managed plant and with average quality of coal, a "Lancashire" boiler, 30 ft. by 8 ft., can evaporate easily 850 gallons per boiler per hour, an increase of 62 per cent. of steam output, as compared with average figures.

It is interesting to note the enormous amount of water evaporated to steam. Taking the average figure of 6·56 lb. of water per pound of coal, a coal consumption of 75,000,000 tons to 100,000,000 tons per annum gives an evaporation of 492,000,000 tons to 656,000,000 tons of water per annum or, say, 9,500,000 tons to 12,700,000 tons per week, corresponding to 2,128,000,000 gallons to 2,845,000,000 gallons per week.

(K) *Feed-Water Examination.*—With regard to the scale troubles, out of the 250 plants, 75 either had no troubles at all or only very slight, 155 were what might be described as "usual" or "medium," whilst 8 cases could be described as "chronic."

With regard to the methods in use for coping with these difficulties, in 182 cases there was no treatment at all (75 cases where no treatment was required, and 102 cases where the scale was simply allowed to form, and was then chipped off again). In 43 cases a water-softening plant was in use, and in 25 cases some form of boiler composition was being added to the boiler-feed water.

In the case of water-softening plants, out of the 43 cases in only 15 cases was the softening plant being worked efficiently and controlled by regular daily analysis. In one or two cases the water was no better, or even worse as regards the presence of scale-forming elements, after passing through the water-softening plants, due, of course, to wrong proportions of chemicals being used.

In certainly well over 50 per cent. of cases where a water-softening plant is installed the proper attention and daily analysis are carried out for a few weeks, and then very soon the plant is left to work by itself, a charge of chemicals being added every day merely as matter of habit, without the least attention being paid to the results, and the variation in the quality of the water. The average hardness of boiler-feed water for the whole country, including treated and untreated water, is probably about 12 grains per gallon. On the previous calculation of a total weekly evaporation of 2,128,000,000 gallons to 2,845,000,000 gallons, this would mean that all the boiler plants of Great Britain have deposited in them weekly no less than 1,600 tons to 2,200 tons of solid material, most of which forms scale.

With regard to boiler compositions, in addition to the 25 cases mentioned, the author has analysed many other samples of boiler compositions. In most cases these compositions are found to consist simply of caustic soda or soda ash, or mixture of these, together with some vegetable product, very often a crude form of tannic acid. Some of these compositions can only be described as extraordinary. Thus one of them had 95 per cent. water, 0·5 per cent. soda ash, and 4·5 per cent. tanyard refuse. If, however, they vary in composition, they seem to show a great similarity from the point of view of exorbitance in price and failure to prevent scale. Most of their "good" effects are due to the caustic soda, and if it is desired to put caustic soda into boilers (which is not to be recommended), this can be purchased at about one-tenth of the price.

As regards corrosion, only a few cases were observed due to "peaty" acid in moorland water, to excessive salt, to sulphuric acid in pit water from pyrites in the coal, or to accidental causes such as mineral acid in the water supply due to the effluent from some other works.

(To be continued.)

TEMPLETS, JIGS AND FIXTURES.
No. VIII.

By JOSEPH HORNER.

A NOTICEABLE change in machine-shop practice is in progress, one which concerns the ratio of the time occupied in setting work to that which is taken in actual tooling. When articles are being set directly on machine tables, the time occupied in setting may often be greater, though often also less, than that occupied by the tooling. But by the use of fixtures, accompanied with the multiplication of tools, and the adoption of progressive methods, the time of tooling per piece is vastly reduced, and the aggregate output immensely increased. The employment of the magnetic chuck has been a potent factor in increasing the output of the lighter classes of ground articles. Little time is occupied in arranging the light, flimsy, often springy, pieces that are laid on the chucks a dozen or more at a time, and being tooled in series the time occupied per piece is nearly negligible. Non-magnetic alloys are held in suitable clips.

It is obvious that the utilities of the plain magnetic table alone, in regard to its capacity for holding, are limited to pieces of no great thickness, and to those having plane surfaces. In all other cases, packings and reinforcements of some kind are necessary, and in articles of irregular shapes, and of considerable depth fixtures are required, the shapes of which are designed specially, as are those for use on other machines, to suit outlines, and to be held with suitable clamps. In some of these cases the magnetic current may not be used. In most it is employed in conjunction with the clamping fixture.

The magnetic chuck is a most valuable accessory in vertical spindle grinding, chiefly because it enables large numbers of small pieces to be dealt with at one time that would otherwise have to be handled singly on the faceplate of a universal machine, or on the plate or chuck of one of the horizontal spindle type, still singly. The vertical spindle machine also has the great advantage of possessing a horizontal faceplate, on the surface of

which pieces can be laid and adjusted more conveniently than they could be on a vertical face. In this respect the analogy is paralleled with that of the vertical turning and boring mill when compared with the horizontal lathe. On the tables of grinder, and boring mill any number of pieces can be arranged and re-arranged with little trouble, and so mass production is favoured.

With regard to the holding power of the magnetic chuck, while this is ample for thin pieces, it is usual in the medium-sized and thicker articles to afford some stand-by in the shape of flanking strips. It is fixture holding the rough pieces ready for grinding. Where a large number of pieces are chucked, and the labour of putting them into the fixture is considerable, it is necessary to have an extra man, or sometimes two, at the bench merely to assist in the loading.

The illustrations annexed are those of fixtures used on the Blanchard vertical spindle surface grinder, made by the Blanchard Machine Company, of Cambridge, Mass., U.S.A. The machine was illustrated and described in ENGINEERING of March 10, 1915, p. 314. Various designs of magnetic

Fig. 260. SECTION X.X.

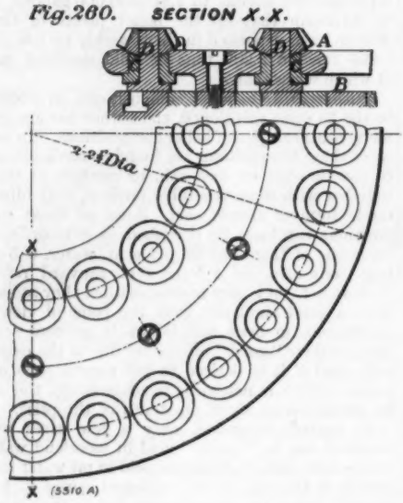


Fig. 261.

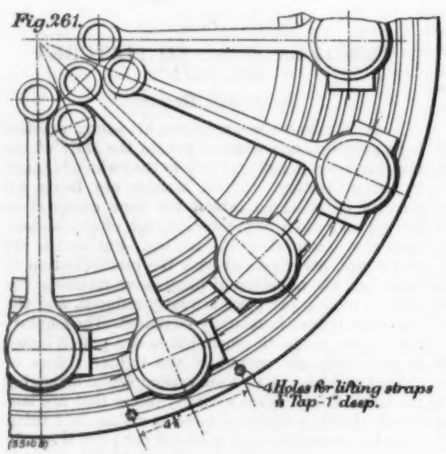


FIG. 262.

FIGS. 260 TO 262. EXAMPLES OF FIXTURES USED ON THE BLANCHARD VERTICAL SURFACE GRINDER; THE BLANCHARD MACHINE COMPANY, CAMBRIDGE, MASS., U.S.A.

necessary to do so, and to insert packings when the faces of pieces are not plane. The stress of grinding is not so great as that of cutting, and the pressure is downwards, which is favourable to the system. As, however, the present subject concerns the fixtures, the illustrations given relate chiefly to these.

So great is the output, that a scheme often employed to increase production is the use of duplicate fixtures, so that one fixture can be loaded at the bench while the other is in the machine holding work that is being ground. These fixtures are exchanged by hand in the case of light pieces, or by a hand or power crane in the case of heavy work. This cuts down the idle time of the machine to that necessary for removing one fixture loaded with finished work, and substituting the duplicate tables were illustrated in the issue of July 2, 1915, page 3. So that it will not be necessary to go over that ground again, but merely describe the fixtures shown here.

Automobile work figures largely in vertical spindle machine grinding. Fig. 260 illustrates a fixture in which two circles of small bevel pinions, 44 in all, are mounted for grinding the small ends. It combines the fixture A, used with the magnetic chuck B, and is one more example of that minute subdivision of tasks of which we have seen so many in the course of this series. Ordinarily, one expects to see a pinion faced at the time of boring. Yet here a rather expensive fixture is designed only for the continuous facing of 44 pinions at one time. This device comprises a holder A, of cast iron, which is screwed to the face of the magnetic chuck. It is bored to receive the bushings C in which fit the steel pins D that enter the bores of the pinions. The pins rest on the face of the chuck with shoulders. The backs of the pinions lie in concavities in the ends of the bushes. The pins are in contact with the N poles of the chuck, while the holding plate makes contact with the S poles, a non-magnetic material intervening. The pinions are thus held in place, both on the pins and on the plate.

The illustration, Fig. 261, is that of a magnetic fixture for holding connecting-rods while the faces only of the big ends are being ground. The chuck is of annular form, since it deals only with the big ends, and the current is, therefore, concentrated on the annulus. The rods, held down by the current, are prevented from shifting laterally, either by loose strips laid on the chuck face between the rods, or by brass plugs entering the holes in the rods, the latter being the method indicated. The bosses of the small ends are thicker than those of the large ends, but as the centre portion of the chuck is cut away, they clear. The hit and miss arrangement permits of getting the maximum number of rods in the circle.

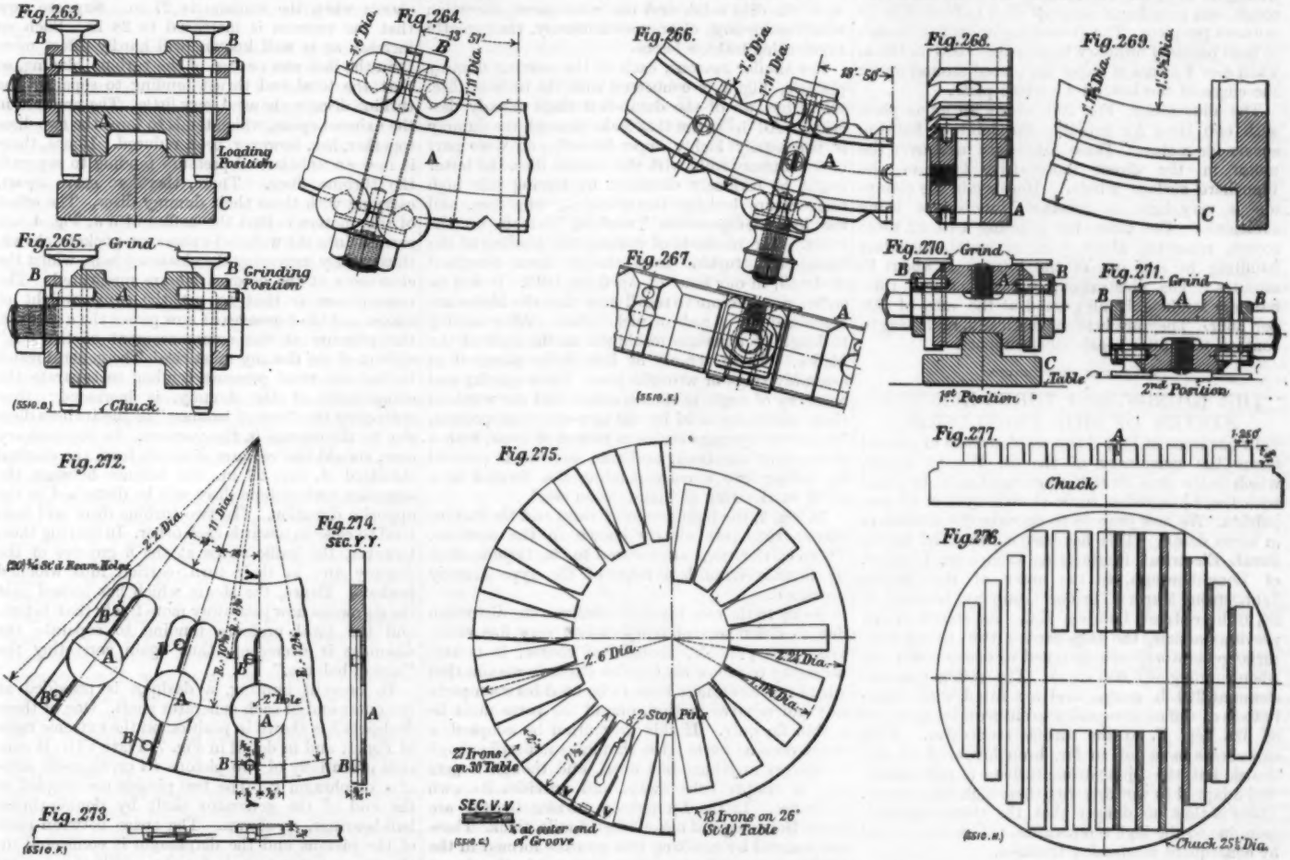
The next example is that of similar rods in which the method of mounting them differs, and in which both ends are ground on both faces. The illustration, Fig. 262, above, shows connecting rods for automobile motors, 15 rods being chucked on

the fixture at one time. Here also an expanding plug locates the large end of the rod, but the small end is clamped downwards and sideways against hardened steel plates by the small dogs and thumb-screws seen. The large end of the rod is thicker than the small end, necessitating two grinding operations on each side of the rod as follows:—First, the large end is ground, next, the chuck of the machine is moved out until the wheel covers only the small end; the wheel is then lowered, and grinds the small end. The rod is then turned over in the fixture, and the same operation is repeated on the second side. The production, removing .050-in. stock from each surface of the rough forging, grinding four surfaces on each forging, is 55 rods per hour.

Figs. 263 to 265 show a fixture for holding 104 ends, and the product is 700 per hour: this for the Ford Motor Company. Three fixtures are used, two being loading on the bench, while the third is on the machine. The clamping is done similarly to the last example. A ring A has vees on inner and outer faces, in which a pair of push rods are held adjacent with clamping plates, each maintained vertically with a pin. Two pairs, inner and outer, are thus secured with a single bolt, Fig. 270, which is prevented from turning by a grub screw, Figs. 270, 271. Two special nuts and bolts on opposite sides, Fig. 266, are used for slinging by. The fixture is carried on an annulus C that lies on the table, Figs. 269, 270, while the faces are being ground. Then, being turned over, Fig. 271, the annulus is removed, and the ends just ground rest on the table, while the ends of the pins are dealt with.

require a fixture in which to secure them, yet there is another way in which the plane surface of the magnetic chuck can be utilised. Thus, in Figs. 276 277, a number of strips of the section shown at A are supported edgewise to be ground at right angles with the faces. This is done by locating them between strips of steel which are parallel and square and so embody the necessary provision. The strips are hardened and ground, ensuring the accuracy of the ground work. It will be seen from the section at A that only one face of the strip need be plane, that to the left hand being bevelled.

Some heavier work is shown by illustrations on page 40. Fig. 278 is an example of a convenient scheme for setting up various irregular castings where the quantity of any one piece does not justify a special fixture. The circular cast-iron plate is



FIGS. 263 TO 277. EXAMPLES OF FIXTURES USED ON THE BLANCHARD VERTICAL SURFACE GRINDER; THE BLANCHARD MACHINE COMPANY, CAMBRIDGE, MASS., U.S.A.

valve lifters at one time to be ground on the ends. Nothing more than this. And the fixture includes a loading ring which is not used when the grinding is being done. The body of the fixture is a ring A, having vee slots on the outer and inner peripheries, in which the articles are held with clamping blocks B, each maintained horizontally with a pin, and clamped with a central bolt. One block clamps two pins. To ensure the lengths being alike, the rods are set by their lower ends on the locating ring C, Fig. 263, this being done at the bench. When the fixture is transferred to the chuck, the rods rest on the chuck face as in Fig. 265. The fixture is located on the table with centring blocks, not shown. So great is the output that three or four duplicate fixtures are made to be loaded while the one on the machine is being dealt with. What possible chance, one wonders, have firms to survive if they attempt to maintain the methods of a few years since in competition with mass production of this character?

Moreover, in the next illustrations, Figs. 266 to 271, even this record is exceeded, for the fixture for the 104 rods is made to turn over to grind both

Figs. 272 to 274 show a magnetic fixture for holding cutters to be ground on the outer sides. Only one of these pieces is indicated by the dotted outlines in Figs. 272, 273. The feature to note is that the lower faces of the pieces are of irregular shapes. In some cases this difficulty is met by the use of packings, in others by recessing the fixture to suit, as indicated in Fig. 273. This fixture being thin, is made of boiler plate, ground on both sides. It has a 2-in. hole A, cut midway of the piece to be held, in order to concentrate the magnetism near the ends of the pieces. Each article is located at the ends by means of stop pins B, which are of machine steel, case-hardened.

Somewhat similar is the fixture for holding common plane irons, Fig. 275; 18 irons are carried on a 26-in. table—right hand, 27 on a 30-in. table—left hand. The fixture has shallow slots milled in it to receive the irons, and these are secured endwise with two stop pins, one at the end of the iron, the other in its slot. Clearance round the irons renders their insertion easy, while the magnetic current, with the pins holds them securely.

Although narrow pieces of considerable depth ground flat on both sides, and is drilled and tapped with holes in various locations suitable for the different pieces that are to be handled. These holes serve to locate and secure jacks for supporting the overhanging portion of the work, and studs for clamping work in position. The cast-iron plate itself is held magnetically on the rotary magnetic chuck of the Blanchard grinder. The example of work shown is a feed bracket for a soap powder grinding mill. Three supporting jacks, and one strap, the top of which is just visible with its nut in place inside of the casting, are used to hold this casting in position. In grinding in this way most of the pressure is, as has already been pointed out, downward, and it is not necessary to secure pieces so firmly against side pull as in milling or planing practice.

The illustration, Fig. 279, shows a feed-gear box for the Blanchard surface grinder set in a fixture for grinding the flange where the gear-box bolts on to the machine frame. It is supported by two vee blocks for holding bosses at the right-hand end of the box, and by one adjustable, and one fixed support at the left-hand end. The bosses are clamped

to the vee blocks by a strap. Another strap is used at the other end engaging an opening in the end of the box, and a thumbscrew seen in front in connection with a similar thumbscrew at the rear (not shown in the illustration) serves to prevent any side motion. The ground surface has to be brought to a definite distance from the centres of the two bosses supported in the vee blocks. For this purpose a pillar is seen on the front right-hand portion of the fixture marked "use one-inch standard block." The top of this pillar is just 1 in. below the height of the finished surface of the box, and by putting a 1-in. block on the pillar, the continuous reading caliper attachment of the Blanchard grinder can be set to indicate when the finished size is reached. The amount of metal removed from this box varies from $\frac{1}{8}$ in. to $\frac{3}{16}$ in. The castings are sometimes very rough, but grinding is accomplished in from 9 to 13 minutes per piece. The ground surface is flat enough to hold pieces of ordinary block paper ·003 in. thick, when 6 or 8 pieces of paper are placed around under the edges of the box on a surface plate.

The illustration, Fig. 280, shows an angle plate with two faces for grinding the joint of half-top covers for motors. These covers are used over the motor in the direct motor-drive type of the Blanchard surface grinder. Here again the clamping is very light, a common thumbscrew being sufficient. The time for grinding two of these covers, removing about $\frac{1}{8}$ in. of metal, including handling in and out of the fixture, is about 10 minutes. The illustration, Fig. 281, shows rifle-hammer forgings being ground at the rate of 300 per hour. They are held magnetically, and lying in contact, they afford each other support.

THE LJUNGSTRÖM TURBO-ELECTRIC SYSTEM OF SHIP PROPULSION.

IN our issue of May 3 last we described in general terms the machinery of the ss. Wulsty Castle, which is the first British seagoing ship to be fitted with the Ljungström turbo-electric system of propulsion. We now propose to describe the machinery in some detail. This has been constructed by the Brush Electrical Engineering Company, Limited, of Loughborough, to the order of the British Ljungström Marine Turbine Company, Limited, of 22, Billiter-street, London, E.C. As stated in our previous article, the ship carries two Ljungström turbo-generators, each designed to develop 625 kw. when running at 3,600 r.p.m. The boilers generate steam at 220-lb. gauge, and are fitted with superheaters of sufficient capacity to ensure a temperature of 625 deg. F. at the turbine stop-valve. High superheats have not, so far, been favoured on ship board, but the Ljungström turbine is particularly well adapted to working with these high super-heats. There is thus no danger that the thermodynamic gain due to the high temperature will be discounted by consequent mechanical troubles.

A general longitudinal section through the turbine and its two generators is reproduced in Fig. 1, Plate VI. The small space occupied by the turbine itself is very striking. The whole of the moving part measures but 28 in. in diam. by 17½ in. in axial length, and its total weight is 4 cwt.

The Ljungström turbine is, as is now well-known, a radial-flow machine. It consists of two discs which carry intermeshing rings of reaction blading. Steam enters the blading near the centre of the discs, and as it passes from ring to ring, impels one disc in one direction, and the other in the opposite direction. Each disc is direct-coupled to a generator, and the two generators are inter-connected for parallel running. Near the outer end of one generator shaft an exciter is fitted, the main governor and oil pumps are located on the same shaft between the exciter and the slip rings of the generator. The turbine exhaust flange is bolted direct on to the condenser, which serves, in short, as a general bed plate or foundation for the whole unit. The weight of each overhanging generator is borne by spherically-ended struts, abutting on spring buffers, as indicated in Fig. 1. By this arrangement, the condenser, turbine and generator casings are all free to expand with changes of temperature, and with a minimum of mutual distortion.

An enlarged longitudinal section of the upper half of the turbine is reproduced in Fig. 2. There are, it will be seen, 39 rings of blading, which are divided up into a high-pressure, an intermediate, and a low-pressure section. The innermost ring of the high-pressure section has an outer diameter of $3\frac{1}{16}$ in., whilst the outer diameter of the ring No. 39 is $28\frac{3}{8}$ in.

Each turbine disc is built up, it will be seen, of three components connected together by flexible "dumb-bell rings." This device, whilst securing accuracy of alignment, enables each component to expand freely without material constraint from the others. The innermost component of the three is exposed to high steam temperatures, whilst that carrying the low-pressure blading may have a mean temperature of perhaps not more than 150 deg. F. Serious expansion strains would accordingly arise were the disc solid, and the consequent distortion would make large clearances necessary, thus greatly augmenting leakage losses.

For similar reasons, each of the moving dummy plates *c*, Fig. 2, is connected with its turbine disc solely by two of the dumb-bell rings already described. All the steam that leaks through the dummy is necessarily highly super-heated, and were part of the dummy solid with the turbine disc, the latter might be seriously distorted by having this high temperature leakage steam on the one face, and the lower-temperature "working" steam on the other. The methods of making the blading of the Ljungström turbine have already been described in detail, in our issue of April 12, 1912. It will be sufficient therefore to recall here that the blades are machined out of rods of nickel steel. After cutting to length, tenons are machined on the ends of the blades. These tenons fit into holes punched in assembly rings of wrought iron. Even spacing and accuracy of angle is thus secured, and the whole is then welded up solid by the oxy-acetylene process. The assembly rings are then turned to form, with a dovetail at the back, and this dovetail is secured by rolling into a corresponding slot formed in a stout carrier ring of high-tension steel.

In Fig. 2, the light assembly rings and the stouter carrier rings are clearly shown in the sections. These carrier rings are secured to the turbine discs by flexible dumb-bell rings of the type already described.

Owing to the care taken to minimise the distortion due to differences of temperature, very fine clearances are possible, though, of course, it is still necessary to follow Sir Charles Parson's maxim that where fine clearances have to be used between parts in rapid relative motion, one of the parts must be a thin fin only. If this precaution be adopted, a touch does no harm; the thin fin is not stiff enough to distort anything but itself, and though it gets hot, it simply rubs away, and provides its own clearance. In the Ljungström turbine the fins are made from strips of nickel steel, 5 mils. thick. These are secured by caulking into grooves formed in the blade rings, and are perhaps most clearly shown near the ends of the low-pressure rings in Fig. 2. Leakage by axial flow of the steam from between the blade rings has, in all cases, it will be observed, to make its way past two constrictions due to these rings, and the loss thus arising is, accordingly, very small. As will be seen from Fig. 2, the four last rings of blading are built up in three sections. This is primarily done to secure strength and stiffness, while at the same time increasing the turbine exhaust area. The load due to the centrifugal forces is thus carried by four rings of solid steel, well distributed, so that the distortion due to the centrifugal load is reduced to a minimum.

When the turbine is at work, the pressure tending to force the two discs apart axially is very considerable, amounting, in fact, to several tons. This end thrust is taken by the dummies shown at *cc*, Fig. 2. Each of these dummies consist of a pair of grooved discs, one of which is mounted on the turbine disc, and the other on the steam chest *d*, which is stationary. Steam flows through the space between the dummy discs, past numerous baffles, and finally escapes into the exhaust chest of the turbine. The arrangement of the baffles is shown diagramatically in Fig. 4. Here A represents part of the rotating dummy disc, and B part of the stationary disc. As will be seen, fins project from one disc into grooves cut in the other. Each of the fins is provided at its outer end with a baffle plate of nickel steel 5 mils. thick. The edges of this plate just clear by some 5 mils or so the adjacent edges of the groove with which they are meshed, and through these narrow inter-spaces the steam must find its way in leaking out to the exhaust.

As shown in Fig. 4, two forms of groove are used in the dummy, the object being to secure automatically an exact balance of the axial thrust, tending to separate the main turbine discs. As represented in Fig. 4, all the baffles are effective, the steam being as effectively wire-drawn at *aa* as at *bb*. This, however, is not, save by accident, the working position of the dummy discs relatively to each other. Let it be assumed, for example, that the end thrust is exactly balanced in the position shown when the vacuum is 27 in. Suppose now that the vacuum is increased to 28 in. Such an increase as is well known, will hardly affect more than the last row or two of the turbine blading, so that the total end thrust tending to separate the turbine discs is changed very little. The pressure in the exhaust space, which tends to force the two discs together, has, however, been reduced. Hence, there is now an unbalanced pressure tending to separate the turbine discs. These, therefore move apart, carrying with them their dummy discs. The effect of this motion is that the baffles at *a a*, Fig. 4, are carried into the widened spaces or pockets shown, thus greatly increasing the clearance here, whilst the clearances at the grooves *b b* are unaffected. The consequence is that to get the same weight of steam past the *b* grooves as now passes the *a* grooves, the pressure at the commencement of the "*b*" section of the dummy must rise. The general result is that the total pressure tending to separate the components of the dummy, is increased; thus correcting the "out of balance" of the turbine discs due to the change in the vacuum. In the contrary case, should the vacuum diminish from the original standard of, say, 27 in., the balance between the dummies and turbine discs will be disturbed in the opposite direction. The two turbine discs will then tend to close in towards each other. In moving thus, however, the baffle strips at the *b* grooves of the dummy are, in their turn, carried into widened pockets. Hence, the steam which has leaked past the *a* grooves now gets away more freely than before, and the total pressure tending to separate the dummies is decreased, thus again correcting the "out of balance."

To prevent hunting, a dashpot is provided at the outer end of each generator shaft. One of these dashpots *h* is shown in position on the extreme right of Fig. 1, and in detail in Fig. 7, Plate VII. It consists essentially of two pistons *i i* on opposite sides of a diaphragm *k*. The two pistons are coupled to the end of the generator shaft by double-thrust ball-bearings, as shown. The space between each of the pistons and the diaphragm is connected up through a non-return ball valve, with the general oil supply to the turbine. An adjustable leak-off, connecting the two sides of the diaphragm is provided at *j*. Any tendency to hunt is damped out by friction at this plug.

As already mentioned, the steam enters the turbine blading near the centre, and flows radially outwards. Were the working agent water, the simplest method of conveying it to the centre of the discs would, no doubt, be to use hollow shafting, through which the fluid would be passed. Such a scheme is impracticable, however, when the working agent is highly superheated steam. Bearing troubles would probably be serious, and the heat which would with this arrangement pass from the steam to the generator rotors would not be welcomed by the designer of the electrical section of the plant. Another plan was, therefore, necessary, and the turbine is fitted accordingly with two steam chests *d d*, Fig. 2. These are ring-shaped steel forgings, which at the one end support the gland bushing, and at the other the standing half of the dummy. To ensure against distortion by expansion strains, these chests are each, it will be seen, connected to the casing by one of the dumb-bell shaped rings already referred to.

Steam is led into these chests by a breeches pipe *p p*, of which one section is shown below the turbine

in Fig. 1, whilst a bastard cross-section, showing the connection to the main steam stop-valve, is reproduced in Fig. 3. The steam chest *d*, is, it will be seen, double walled, and the steam pipe passes through both walls into the inner section, which surrounds the shaft, as best seen in Fig. 2. If the turbine is intended to take an overload, a special valve is fitted which admits steam into the outer annulus of the chest, from which it enters the turbine through the by-pass openings shown at *k k* in Fig. 2. In the present case no over load valve is fitted, but a pipe not shown in the figure allows steam to be drawn off from this annulus at about 40lb. pressure for feed heating purposes. The pipe shown to the left does not connect with the steam chest at all, the section being a bastard one, but traps the leakage from the glands. To reduce radiation and convection losses, the exposed outer surfaces of the steam chest are all jacketted, as indicated at *y*, Fig. 2.

Each turbine disc is mounted on a conical seat, formed on the end of a short stub end of hollow shafting *s*, and is secured there by four conical pins, which are held in place by the plug *w*. The stub shaft, in its turn, is registered into the end of the generator shafting, and secured in place by the bolts *t*. To dismantle the turbine, the upper half of the casing is removed, and also the top caps *u* of the bearings, which are lifted by a shackle screwed into the tapped hole shown. The bolts *t* can then be removed. The two turbine elements are next clamped together in a special fixture, which holds them in true alignment with each other, and the dummies. The generator shafts are then withdrawn sufficiently to clear the registering spigot on the stub shaft, and the turbine can then be lifted out complete and dismantled in detail if required. The bolts *t* are knurled in the body, as indicated, and when home, soft metal is caulked down on to the knurling, thus effectively locking the bolts in place.

As will be seen, oil baffles are provided at *x* to prevent the escape of lubricant from the bearing casings.

The steam stop-valve is combined in one casing with the governor valve, and is shown in position to the right of Fig. 3, whilst Figs. 5 and 6, Plate VII, shows the whole arrangement in detail, and to a larger scale. The stop-valve A, Fig. 5, is of the ordinary pot-lid type, and is surmounted by a balanced double-beat governor valve B, secured to the same spindle. This valve B is designed so that it does not open appreciably until A is well clear of its seat. As a consequence, B may be moved through a considerable range of opening without sensibly affecting the steam way past A. The governor valve is operated by oil pressure, which is admitted below the spring-loaded plunger C. The pressure of this oil supply is regulated by the governor, as will be described later on. As the speed rises, the governor reduces the oil pressure, so that the spring moves down C, and with it the governor valve B, thus throttling the steam supply. The screwed spindle D is simply used to lock home the valve A. It can be used to close this valve, but not to open it. Hence, in starting up the turbine, the procedure is to run up D, thus unlocking the valves. The latter, however, cannot yet open, because the spring above C is sufficiently powerful to hold A closed against the full steam pressure below it. On raising, however, the pressure in the oil circuit, either by a hand-pump or by an auxiliary steam-pump, the piston C is lifted, opening the valves and admitting steam to the turbine. Since the one oil circuit supplies both this piston and the bearings, the arrangement just described ensures that the turbine cannot be started up until the bearings are thoroughly flushed.

The valve shown at E, Fig. 5, is an equilibrium valve. In the position shown, it admits oil below the piston C only. Should, however, this valve E be raised, it establishes equilibrium between the upper and lower sides of C, which is then forced down by the spring, and closes the main-stop valve A. The valve E is, it will be seen, provided with a spring which constantly tends to raise it into the equilibrium position. This is resisted by the stop F, and if this stop be thrown over by the handle or otherwise, the turbine is forthwith shut down. A cable passes through the upper hole shown in F, and so long as it is taut, the stop is held in the position shown, and the valve E remains in its lowest position. This cable is connected to the emergency governors (of which there are two, one for each generator shaft) in such a way that if either governor acts, the cable is slacked off. The spring is then able to push over the stop F and move up E.

A strainer G is fitted below the stop valve A to prevent loose objects accidentally left in the steam pipe being carried into the turbine.

As already mentioned, one exciter is used for both generators, and is arranged in the left hand side of the set as indicated in Fig. 1, Plate VI. Between it and the generator, the governor, oil pumps and oil tanks are situated. A cross-section through these is reproduced in Fig. 8, Plate VII. The governor, it will be seen, is driven by a spiral-gearing. The main oil pump, which is of the gear type, takes its drive from the bottom of the governor spindle. The weight of the latter is carried on a ball thrust, as shown.

The lever I, shown to the left of Fig. 8, is keyed to the same shaft as the lever H, Fig. 5. It operates the "overtaking gear," by means of the link work shown. The governor, as the speed varies, raises or lowers the rod J, and with it the piston valve, which controls the supply of oil to the piston C, Fig. 5. The arrangement of this valve is shown to a larger scale in Figs. 9, 10, and 11, Plate VIII. As there shown, the piston valve operated by J, moves in a sleeve coupled up to the overtaking gear. The oil supplied by the pump finds its way past the piston valve into the chamber K, which is coupled up to the oil supply main.

If the governor lowers the piston-valve, the oil will be less throttled in its endeavour to escape past the valve. The pressure below the piston C of the stop-valve gear, Fig. 5, will thus be increased, and the governor valve more widely opened. As the spindle of this valve rises, it carries with it the lever H, Fig. 5, and as I, Fig. 8, is keyed on the same shaft, the link L is lowered, carrying with it the sleeve. The effect of this is to diminish the oil way past the piston-valve, and a certain equilibrium is thus established until a new variation in the load brings the governor again into action. By this arrangement all danger of hunting is completely eliminated. As will be seen, spring-loaded relief valves are provided, both on the discharge main from the pump and on the upper part of the moving sleeve. The oil pressure can, accordingly, never become excessive. A gauge-glass, showing the oil-level in the tank is provided, as indicated in Fig. 12. The oil-cooler is fitted on the oil-delivery main, as shown at M, Fig. 9.

Enlarged sections of the main oil-pump are represented in Figs. 13 and 14, on Plate VIII.

A turbine-driven auxiliary oil-pump is fitted, as shown at N, Figs. 9 and 10. The pump, it will be seen, is of the centrifugal type. It is driven by a simple impulse steam turbine, having a single convergent-divergent nozzle, as indicated in Fig. 10. The steam supply for this turbine is taken from the main steam valve chest, and the exhaust passes direct to the condenser. This auxiliary pump is used in starting up the turbine, and supplies the pressure oil needed for opening the main steam stop-valve, and for flushing the bearings. An automatic valve is fitted on the steam supply, which cuts off the steam once the main turbine is fairly started, and the main oil pump in operation. It further starts up the auxiliary pump automatically should the main oil pump fail. Details of this automatic valve are represented in Figs. 15 and 16, Plate VIII. Here O represents the valve, which is, it will be seen, coupled by link work with a spring-loaded piston P. The space below this piston is connected to the main oil-pump discharge, and so long as the pressure here is below normal, the piston is forced down by the spring, and holds the valve O open, and the auxiliary pump continues in operation.

(To be continued.)

MAGNESITE IN THE UNITED STATES.—The production of magnesite in the United States, says *The Iron Age*, has grown from 9,000 tons in 1913, to over 300,000 tons in 1917, some 200,000 tons coming from California and about 100,000 tons from Washington.

THE PHYSICAL SOCIETY OF LONDON.

AT the meeting of the Physical Society of London, held on June 14 at the Imperial College of Science, Professor C. H. Lees, F.R.S., president, in the chair, a discussion took place on "The Teaching of Physics in Schools." Sir Oliver Lodge, who opened the discussion, said it was desirable that the ordinary man should know more about physics than was the case at present. The teaching of science in schools was a difficult matter. There were many methods, possibly many good methods, provided the essential enthusiasm for the subject was present. To teach the subject to scholars with a view to later specialisation was easier than to make it a part of a general education. You have to interest them in the subject, and avoid making it repulsive, covering a wide ground without too much detail. For children the synthetic method was preferable to the analytic—i.e., you must begin with principles and build up rather than start with the so-called "common object" and analyse into principles. Most common objects involve too many principles and too much mathematics. Many teachers overdo the measurement of things. It is the things themselves that are really of interest to scholars. For the majority of children we must make science one of the humanities.

Professor A. Gregory said that about thirty years ago the Association of Headmasters evolved a system of science teaching, the main feature of which was quantity rather than quality. This had been generally adopted, and the result was that the vast majority of boys on leaving school know nothing beyond how to make a few more or less precise measurements of specific heat, &c., and are ignorant of the elements of such everyday things as electric bells. A laboratory course should be associated with descriptive lessons, which should be as independent of it as possible. Teachers should consider whether or not it is possible in association with a society like this to formulate a course suitable for the needs of the ordinary boy and girl.

Mr. C. L. Bryant said the importance of science in general education was that it inspired the search for truth based on evidence rather than on authority, and illustrated the laws of cause and effect. In his experience boys did not want to know the principles of science. They were interested in motors or steam engines, but not in the details of steam pressure. He thought that they learnt more readily from the machine than from a study of principles. The worst fault in the teaching of science in schools was the neglect of mechanics. The traditional character of examinations greatly hampered teachers.

Dr. T. J. Baker said that an important consideration in dealing with this question was that of age. The conditions of work at a university were so different from those at a school that a boy of 16 must be very advanced indeed to profit by a university course. Boys up to 18 were better at school. He circulated a syllabus of the maximum that should be expected from boys of 18 who had been specialising for one to two years. He emphasised the difficulties due to the want of knowledge of mechanics.

Dr. F. W. Sanderson, in a telegram apologising for absence, suggested the appointment of a small committee to consider the matter.

Mr. C. E. Ashford described the aims and procedure of the science teaching at the Royal Naval Colleges of Osborne and Dartmouth. The course in physics begins with an unsystematic treatment of hydrostatics, and work begins at once in the laboratories and engineering workshops. The effect of the rapid alternation of theory and actual practice was favourable to both, not least in the case of young boys. Workshops practice makes demands on the recently acquired stock of knowledge, and stimulates interest in theoretical work. The comprehension of mechanical principles seemed to be a function of age; the commencement of physics cannot wait for the attainment of that age, and many masters successfully attempt the early stages of physics without depending on mechanics.

Mr. A. T. Simmons said that hitherto school courses of physics had been designed on the assumption that school work is only preliminary to a fuller university course. This, however, only applies to a small fraction of the pupils, and the teaching of physics in schools will only be satisfactory when it is recognised that the course must be complete in itself. What should be decided therefore was what parts of physics should be known by every educated citizen, and what steps should be taken to make it easy for the secondary school pupil to acquire this knowledge at school. He deprecated the common habit of beginning laboratory practice with dry-as dust measurements of lengths, areas, value of π, &c., which sickened the beginner. The use of the laboratory should begin where water and the balance are necessary.

Professor F. Womack said his outlook on the subject was probably somewhat narrower than that of the other speakers, as the students he had to deal with were men going in for medicine and women going in for teaching. They entered at 17½ or 18 years, and for some years he had taken statistics of the knowledge which they possessed on entering. In the last few years 34 per cent. had no knowledge whatever of physics. Classics appeared to predominate in the curriculum of most schools, and a boy who went in for science was regarded as of inferior intellect. Science should be treated from the physical side, and should not be handled by the mathematical master. He approved of Sir Oliver Lodge's suggestion that the study should be made as humanistic as possible. It would probably be a gain to avoid a cut-and-dry syllabus in the early stages, leaving room for the initiative and judgment of the teacher.

Mr. J. Nicol said that science teaching of the best type

SELF-PROPELLED LOW-CLEARANCE SHOVELLING MACHINE.

CONSTRUCTED BY THE MYERS-WHALEY COMPANY, KNOXVILLE, TENNESSEE, U.S.A.

(*For Description, see opposite Page.*)

FIG. 1.

should satisfy and stimulate the interest of the boy, when it would frequently create an interest in scientific progress, the pursuit of which will serve as an intellectual recreation through life. Too much time is spent on laboratory exercises, which yield definite numerical results, because of the ease of checking and assessing marks. Other parts of the subject though equally important, tend to be neglected. There ought to be lectures of a general character illustrated by qualitative experiments and lantern slides showing the application of science to everyday life.

Mr. E. Smith showed lantern slides of a design for a school laboratory suited for the rapid alternation of lecture and laboratory work, in order that short experiments may be interspersed with explanation and discussion.

Mr. F. B. Stead thought that much of the alarming uniformity that had been mentioned by speakers was due to the influence of conditions, such as the general traditions of teachers, examiners, &c., and last, but not least, to text-books. He agreed that the preliminary mensuration work should be done by the mathematics teacher. There was a tendency for measurements to be regarded as an end in themselves. It was more important that a boy should know that there were such things as specific heat and latent heat and their bearing on everyday phenomena, such as the effect of sunshine on land, than that he should begin by measuring those quantities in the case of copper or ice. Attention had been directed to two methods of teaching—one deducing the principles from the machine, and the other explaining the machine from the principles. These in theory were diametrically opposed, but the thought that in practice they would very frequently be found in combination to a greater or less extent.

Sir Oliver Lodge, in closing the discussion, said the main point of difference between his own views and those expressed by any of the speakers was whether the synthetic or analytical method were preferable. It was possible, as suggested by the last speaker, that the difference was not so great in practice as in theory, but he would nevertheless expect any systematic course to begin with principles. It was no doubt the machine itself in which the pupil was interested, but the problem was how to get the principles out of the machine.

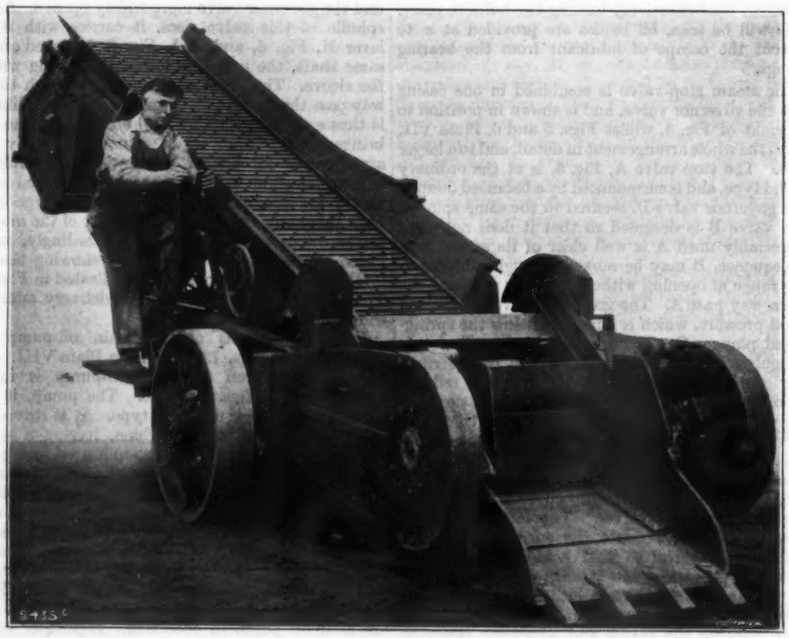


FIG. 2.

CADMIUM IN BRASS.—As much of the zinc now imported into France contains considerable proportions of cadmium, Léon Guillet (*Comptes Rendus*, May 6, 1918) has investigated the influence of cadmium on the mechanical properties of brass. He prepared alloys containing 70 per cent. to 60 per cent. of copper, 28 per cent. to 40 per cent. of zinc, and up to 4·54 per cent. of cadmium; the high percentage of cadmium was accompanied by a relatively high percentage of lead, up to 0·43 per cent., to which Guillet does not draw attention. The other impurities were iron and tin, neither present to more than 0·1 per cent. He found that cadmium had little influence on the properties of the brass, as long as the Cd content did not exceed 1 per cent.; higher Cd percentages are, fortunately, rare. The influence of cadmium was distinctly deleterious; it lowered the hardness and the general strength, and this was particularly noticeable in the impact tests, which were made on notched bars. The elongation was hardly affected as long as the Cd percentage remained below 2. For low percentages the cadmium could be traced in fine lines surrounding the grains of alloy; when the percentage went higher, the cadmium was seen to be isolated in round grains; it would appear that the cadmium enters into the solid solution when present in small proportions. The detrimental effect of the presence of cadmium were more striking in a brass than in $\alpha - \beta$ brass.

JAPANESE MURORAN STEEL WORKS.—According to *The London and China Telegraph*, it is reported that the Japan steel works at Muroran, Hokkaido, have a plan under contemplation to undertake new enterprises in the Kwansai district. This concern is a joint stock company with a capital of 15,000,000 yen, of which 7,500,000 yen is subscribed by the Mitsui firm and 3,750,000 yen each by the Armstrong and Vickers companies. The Japan steel works were recently credited with a project for establishing factories for building vessels and warships and manufacturing arms and ammunition and general machinery, with a capital of 30,000,000 yen, somewhere in the Kwansai district. It is now reported that the Muroran company has bought a large portion of the shares of the Matsuda works at Osaka, and has succeeded in obtaining entire control of the branch factory at Kaidaichi, Hiroshima prefecture, of the Osaka concern. According to the *Jiji*, the present directors of the Matsuda works will be asked to resign, and a new directorate will be elected at a general meeting of shareholders to be held at the beginning of next month. It is reported that the capital of the Osaka concern, which is at present 1,500,000 yen, will be increased, this being the forerunner of the projected enterprises in the Kwansai district of the Japan steel works at Muroran.

ELECTRICALLY-DRIVEN SELF-PROPELLED LOW-CLEARANCE SHOVELLING MACHINE.

CONSTRUCTED BY THE MYERS-WHALEY COMPANY, KNOXVILLE, TENNESSEE, U.S.A.

Fig. 3.

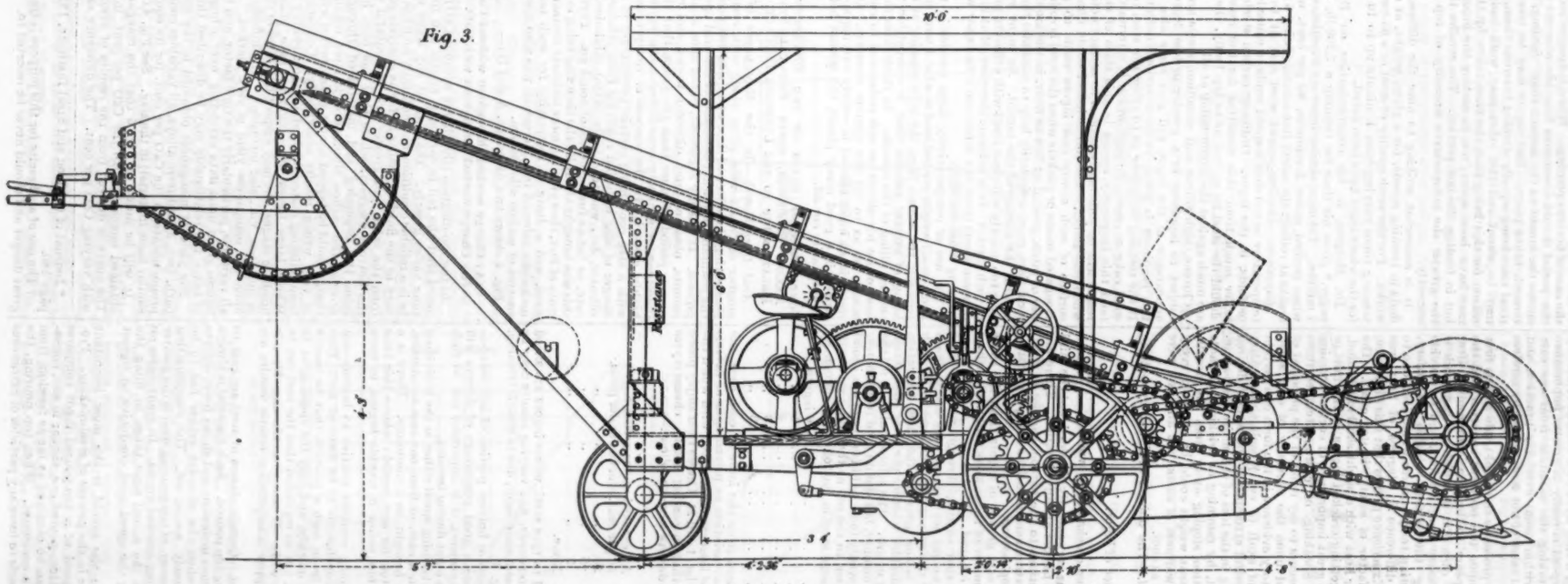
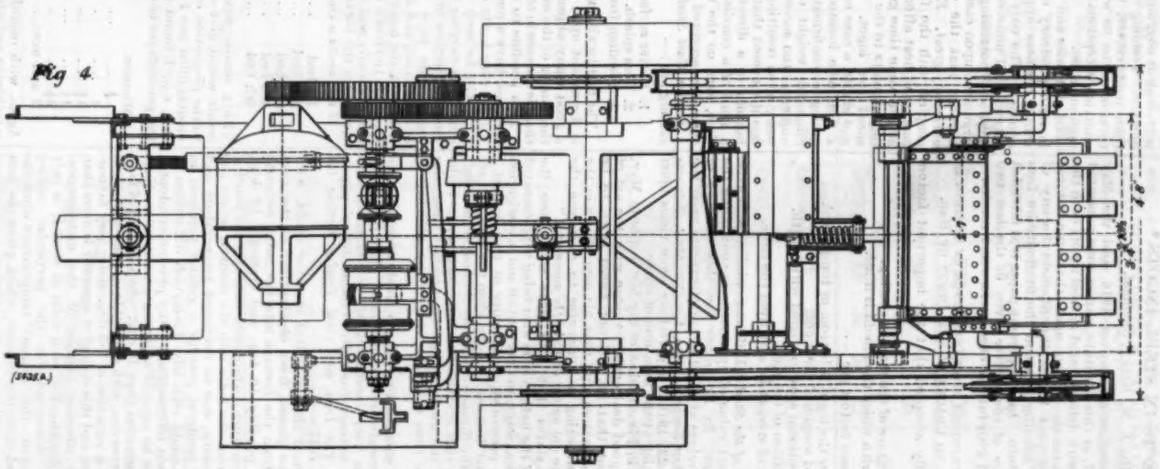


Fig 4.



IN a former article* we gave detailed illustrations of some electrically-driven, self-propelled, low-clearance shovelling machines, constructed by the Myers-Whaley Company, Knoxville, Tennessee, U.S.A., who are represented in this country by Mr. F. A. Perry, of 63, Queen Victoria-street, London, E.C., and we now give in the views, Figs. 1 and 2, on the opposite page, and in the elevation and plan, Figs. 3 and 4, annexed, illustrations of another shovelling machine of this type which has been constructed by the same company for Russia, where it is to be used for loading iron ore and limestone into trucks for charging blast furnaces. This machine can handle about 45 cub. ft. of loose material, or of about 1 ton per minute. It is operated by one man; it moves round freely and can be propelled forward or backward.

In working order, the machine illustrated weighs about 6 tons; it has a length of about 20 ft. and a height of 8 ft. 4 in. overall; both the length and height being made to suit the wagons used. The width overall is 6 ft. 3 in., at the drive wheels. The wheel base is 6 ft. 2½ in. The drive wheels have a diameter of 34 in. and a 7-in. face; whilst the steering wheel is 24 in. by 7½ in. The shovel has a width of 34 in. The machine is equipped with a 20-h.p. electric motor and 250 ft. of mining machine cable; the power consumption amounts on an average to 12 h.p. Figs. 3 and 4 give the details and principal dimensions.

* See ENGINEERING, vol. c, page 35.

IODINE RECOVERY FROM DILUTED RESIDUE.—As iodine is now one of the comparatively scarce chemical substances, and is widely used also in metallurgical laboratories, the following note, due to Mr. H. F. Stephenson (*The Analyst*, 1918, pages 165-6) on the recovery of the iodine from analytical waste, may be of interest. The waste liquid, neutralised or faintly acid, is treated with mercuric chloride to precipitate the iodine as red mercuric iodide. The moist precipitate is treated at 45 deg. C., with hydrochloride acid, containing 20 per cent. of nitric acid, the mixed acids being added gradually until the iodide has all been decomposed; the iodine is then filtered off, the filtrate being again mercuric chloride ready for further use on concentration. The moist iodine may be converted into iodide; for this purpose, it is gradually washed into a flask containing water and iron filings. When the mixture is shaken and afterwards heated, ferric iodide is formed, which, decomposed by caustic potash, yields potassium iodide, to be gained by crystallisation, whilst the iron is precipitated as brown ferric hydrate.

DEFECTS IN STEEL INGOTS.*

By J. N. KILBY, Sheffield.

AT the September meeting of 1916, and the May meeting of 1917, at this Institute, papers were presented by me dealing with defects found in steel ingots or in the article manufactured. Papers upon the same subject have also been read before the Sheffield Society of Engineers and Metallurgists and the Staffordshire Iron and Steel Institute. In this present paper it is intended to extract some of the matter given in the last two papers, coupled with further observations and results.

PREVIOUS CONCLUSIONS UPON INFLUENCE OF CASTING IN RELATION TO CRACKS IN THE INGOT OF BAR.

It is generally accepted that the important factors are :—

1. Temperature of the steel at casting.
2. Speed with which the mould is filled.

Other yet lesser factors are :—

1. Whether the ingot is bottom or top-poured.
2. Size and weight of the ingot.
3. Cross-sectional area compared with length.
4. Composition of the steel.
5. Weight of steel to be cast from the ladle.

Temperature of the Steel.—Different opinions still exist as to the present value of pyrometry in controlling the furnace product. In November last this variance of opinion was obvious at a gathering of experts upon the subject (Faraday Society. See ENGINEERING, November 9, 16 and 23, 1918). I give here some views upon the matter, which at the least do not agree.

Dr. Rogers, in his criticism of my last paper in May, says "that a good deal could be done with the aid of pyrometers, but that he had not found them to be sufficient in themselves, and that his own efforts in the direction of inventing a pyrometer to overcome the limitations were not as yet completely successful."

He further states that "he quite well knew the temperature of the bath, vision also being supplemented in many practical ways, so that control and investigation of the process presented no difficulty in that respect." No doubt a good deal can be done when the temperature of the steel in the furnace can be determined accurately : it is not much that divides, but, unfortunately, it is the mainspring of the whole. High temperature just prior to tapping can then easily be adjusted by additions of scrap.

Mr. Service thought I relied too much upon what he termed "experience and eye method." The opinion of Mr. Service is very interesting when compared with the following extract from Mr. Cosmo Johns' paper, published in *The Iron and Coal Trades Review* for November 16, 1917 :—

"It was found that a skilled observer could, with the aid of blue glasses, from observations of the steel as it poured from the furnace into the ladle, estimate differences of possibly 10 deg., and certainly 15 deg., apparent temperature ; while men, watching the pouring of the steel from the ladle into the moulds, where the increased viscosity, due to decreased temperature and other factors, rendered possible a greater precision in the estimate, could certainly distinguish differences of 10 deg. apparent temperature. Any pyrometer adopted must therefore be capable of giving consistent readings with greater precision than 10 deg. As a matter of fact, a trained observer can, with a suitable instrument, obtain readings with a variation of 2·5 deg. under very favourable conditions, and this degree ot accuracy is more than sufficient for effective control of the metallurgical processes employed. For each class of steel it is only necessary to determine—for the particular casting method employed—the 'normal' temperature when the steel is tapped from the furnace, which gives the best result. This 'normal' may vary as the process employed is modified. The measurements involved are therefore divergences from the particular 'normal' adopted at the time, and as the range of variations in regular practice is small, no appreciable error is introduced by considering the differences in the pyrometer readings as temperature differences. The desirable temperature varies 10 deg. apparent from the normal, and a very high percentage of the casts does not appreciably exceed these limits. Temperature variations of 20 deg. apparent give rise to serious difficulties, and 15 deg. apparent can be considered to be the variation admitted in practice. These limits are for special steels ; they are wider for ordinary commercial steels."

A statement by Dr. W. Hatfield on "Pyrometers from the Standpoint of Ferrous Metallurgy," published in *The Iron and Coal Trades Review* for November 9 of last year, may be of interest at this point :—

"Although the temperature at which steels are cast must have an influence upon their ultimate physical properties, no ready or really re iable method for measuring such temperatures from the works standpoint is available. This is a considered statement. It would obviously be of considerable use if the temperatures of successive heats of steel could be controlled and determined."

When one speaks of casting temperatures, the terms hot or mild are purely relative to the product desired, though they are often used without full regard to accuracy. For instance, a cast alleged to be on the "hot" side may produce ingots free from cracks, provided the period of filling be prolonged to the correct extent by using correct-sized nozzles, or secondary ladles, or, when bottom casting, putting down a sufficiently large number of ingot moulds per bed. Further, a cast alleged to be on the cool side will most certainly yield ingots which will crack at cogging, if they have been teemed relatively quickly. Teeming speed is really of greater importance than temperature, taking the variation from one cast to another to be within usual everyday practice, and omitting exceptional cases of hot steel caused by careless manipulation.

Of all trades and processes the steel trade stands first in its dependency upon the personal equation and the whole business appears to be one compromise after another. The only direction in which we can work is to avoid all unnecessary complications, and to provide methods possessing the widest margin of safety. Argument upon casting temperatures would lead one to suppose that the difference in degrees of heat was extremely great. Experience proves that this difference, coupled with the factor of safety, is not great. The casting of heat after heat with a slight skull left behind, at the same time getting cracked ingots in the mill or forge, points to the great importance of correct teeming speed per ingot. Speaking of casting temperatures and skulls, a case occurs to my mind of the principal of a firm who insisted upon the necessity of cool steel, asking for confirmatory evidence in the form of a certain minimum weight of skull (5 cwt.) each time. After numerous too successful attempts at the weight desired (very often resulting in the loss of the entire cast) someone discovered that, by ramming or bricking the ladle bottom in a direction sloping away from the nozzle, a skull of a consistent weight could be obtained every time, even on the warmest of casts, but all casts were thereafter accepted as cool.

Bottom Cast Steel.—The objects achieved by bottom casting are :—

1. Better surface of ingot.
2. Less splash.
3. Freedom from cracks during working.

The first two items are generally obtained, but the third is dependent upon factors already detailed. There are a good many objections to the bottom casting of steel, the danger of the extraneous inclusions being far greater than is the case in top casting.

It is possible to cast groups of ingots from the same heat and have a number of them work well while others will be very badly cracked.

It will be seen that casting through varying sized nozzles, or varying weight per bed, one may easily obtain great differences in the actual time required to fill each ingot. The time factor governs the first formation of solid steel, and decides whether the later contraction will crack the ingot or not. The steel should not fill the mould in too free a manner, but should tend to scum over and gradually and evenly form a thin cover of semi-solid steel from the bottom to the top as the filling proceeds.

If one casts a charge steel in the following manner :

1st bed	...	...	...	...	6 ingots.
2nd bed	...	...	...	...	5 ,,
3rd bed	...	...	...	...	4 ,,
4th bed	...	...	...	...	3 ,,
5th bed	...	...	...	...	2 ,,

with a similar stream from the ladle in each case, the result would give a variation in percentages of defects to the proportion of increase of the speed with which the moulds filled (see Figs. 1 and 2). Cheese tires amply prove this, *e.g.*, I found that in casting 480-lb. cheese tyres the percentages of defects were as follow :—

Minutes.						
¾	...	...	All cracked under pressure.			
1	...	...	50 per cent. cracked under press.			
1¼	...	...	25	,,	,,	,,
1½	...	...	5	,,	,,	,,
1¾	...	...	2	,,	,,	,,
2 and over...			None.			

Again, with regard to tyre steel, where ingots are sliced into blocks and afterwards, &c., varying results may be obtained upon the self-same ingot, due to erratic teeming, as indicated by Fig. 3.

Regarding the base or bottom portion of any bottom-poured ingot (where a good percentage of defects will show, if visible anywhere), it is important not to rush the first foot of the ingot during teeming.

Variation in the teeming speed either in the individual groups of ingots, in a cast, or from one cast to another, is therefore to be brought to a minimum. There is a definite time per ton for any mould : above this time no cracks result, but below it trouble begins, in spite of "cool" steel.

From the foregoing remarks relative to bottom-cast steel, the logical conclusions to be deduced are : That the pitman must be in such a position that he cannot possibly teem too quickly, and that the speed must be such as to be safe, yet so regulated that the cast can be successfully dealt with. Where slow teeming depends entirely upon stopper manipulation erratic results are certain.

Top-Poured Steel.—Certain classes of steel are cast to advantage by being top poured. Such material is always freer from extraneous inclusions and shows fewer defects from this cause when the ultimate article has to be machined and closely scrutinised. The compensating disadvantage, however, of top pouring steel is the greater liability of obtaining cracked ingots. In many cases no regard is paid to the actual time taken in filing the moulds or finding the speed most conducive to correct results.

Speed in filling the mould is the most important factor at any time in the process of steel-making. Provided that the speed of a top-poured ingot compares equally with a bottom-poured one, similar in size, corresponding results can be obtained as far as freedom from cracks or rokes is concerned. When top pouring, the flow of the steel tends to force any particles of extraneous matter to the sides of the ingot, thus making a purely surface defect, as compared with an embedded one in the case of bottom pouring. When taking teeming times the period should commence from the moment the steel enters the mould to the instant that "feeding," as it is termed, takes place. Two ingots may be teemed, the total time being equally divided between them, yet one may be sound and the other may work badly ; the reason for this being that the time taken by the latter may have been spent, not in casting the ingot proper but in feeding the last portion. The smaller the ingot the greater the comparative necessity of top pouring correctly.

It is somewhat striking to note the differences one finds in teeming speeds, for a given weight, at different works. For the same quality of steel in a 65-cwt. ingot, teeming times varying from 1 minute up to 10 minutes for the whole ingot have been noted.

Dr. Burgess, in his communication on Brearley's paper,* gives his time for teeming a 7,200-lb. ingot as 1 minute. Taking a similar ingot my experience is that, when teemed under 3 minutes, 80 per cent. will show cracks at rolling, the safety line actually being 6 minutes.

Lappiness.—Bottom-poured steel cast at too low a temperature or too slow a speed tends to cause lappiness or folds, in the ingot. Ordinary carbon steels do not suffer much from this condition for the reason that, should the steel be so cool as to lap badly, the chances are much against the mould filling at all.

Chrome, high silicon and vanadium steels are always subject to lappiness in a greater or less degree. The appearance of the ingot will give some idea whether this lappiness is going to be a serious defect or not. If the teeming is so slow as to allow the steel to form a solid cake or cover, through which it afterwards bursts (and this frequently occurs in this class of steel), the result will be sufficiently serious to attract notice later, when machining. The formation of oxide films on the surface of such slowly cast ingots tends to give fine elongated seams or pockets when the steel is rolled. The use of pitch, ground as fine as flour, in the mould as the steel rises, must necessarily help to minimise the danger, as also the tarring of the mould. An ingot scumming over too quickly will clean itself with a minute proportion of such pitch.† It is evident, therefore, that in the case of some steels there is a minimum rate below which the teeming must not drop.

The use of comparatively large nozzles in the ladle and a small weight per bed lead to what I term spasmodic teeming, the stream from the ladle running at full force being of greater volume than is compatible with the correct filling of the moulds. In these cases the teemer has to use his discretion and endeavour to control the stream so as to fill the moulds correctly. Often the result is an ingot teemed in widely varying speeds and lapped in a good many places, the stream being often momentarily cut off.

COMPOSITION OF SLAGS OF THE DIFFERENT STEEL-MAKING PROCESSES, THEIR PHYSICAL STATE, AND RELATIONSHIP TO THE ULTIMATE PRODUCT.

Acid Open-Hearth.—In the May paper of 1917 a number of charts were given along with certain facts illustrating the effect of lime upon slag composition and the resultant physical conditions of the acid open-hearth process. It was my argument, based upon analyses and records, obtained from different works, and extending over a period of more than ten years, that the use of limestone or similarly constituted basic material, was highly essential to the success of the process. That, with a slag containing certain percentages of lime, the danger of slag inclusion resulting from retained oxides, silicates, &c., was to a large extent minimised, at any rate, as far as furnace control could go. Further, that this was brought about by the lime slag being in a perfect state of flux, thus yielding more intimate contact with the steel, and a state of receptivity for such undesirable inclusions referred to. Reference was also made to the control of carbon elimination.

Fig. 4 shows two diagrams, A and B :—

(A) Charge worked throughout without CaO.
(B) Charge worked throughout with CaO.

In the top diagram (the charge without CaO) it will be noted that the fall in carbon is erratic and for a given time varies greatly. The bath at any stage would not be in a reliable condition, and naturally such heats usually vary in the finished results as far as analysis goes, apart from the other and greater evil of doubtful steel. In the bottom diagram, where CaO has been introduced from the beginning and maintained throughout the process, the carbon elimination is more regular, and a charge could be tapped almost at any period without fear of very wrong results analytically. Consistent results from finishing material added are more readily obtained. Where large losses of manganese take place at the finishing stages, one may suspect bad cases of the trouble in question, viz., slag inclusions. The influence of CaO upon the manganese yield is very marked. Including all variables, particularly the time factor, and basing the figures given upon data extending over a huge number of casts, the relationship may be described thus :—

The yield of manganese obtained in the steel in the bath, from added ferro-alloys, all variables considered, is proportionate to the CaO per cent. (or its equivalent of similar basic material) in the slag. See Fig. 4A or Fig. 5.

It will be noted in Fig. 5 that the manganese yield obtained increases with the CaO per cent. in the slag. The curve is derived from the results of average casts, with varying CaO per cent. The difference as shown is

* Paper taken as read before the Iron and Steel Institute, May 3, 1918.

* Journal of the Iron and Steel Institute, 1916, No. II, page 180.

† The use of anthracite for this purpose is fraught with great danger and should never be resorted to.

about 20 per cent., or in the actual figures 0·18 per cent. manganese. In establishing the records identical conditions (excepting CaO content) were aimed at, the time factor receiving the greatest care. I was shown some interesting figures recently, proving how defects due to slag inclusions in certain classes of ingots ran in the inverse ratio to the loss of manganese in the bath, or corresponding increase on MnO in the slag. There was naturally a decrease in the FeO present. The dominant feature governing the whole was, without doubt, the CaO per cent. in the slag at tapping.

"Dead melting," so often referred to, can be obtained at any period of the process after boiling, if the two

Fig. 1.

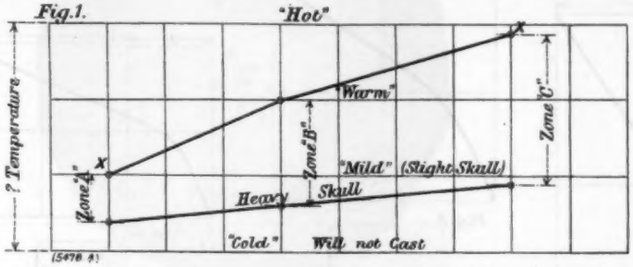
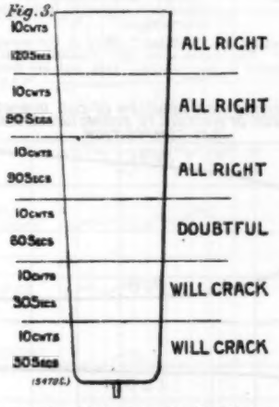


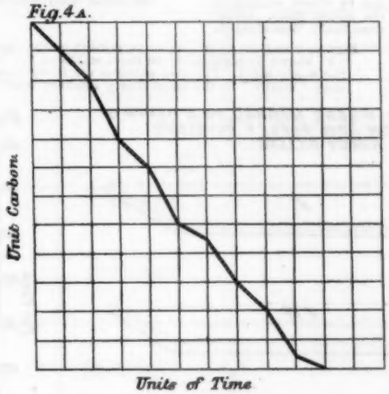
Fig. 1. Zone "A."—Nozzle, 1½ in. Where the ladle, running at full stream above the capacity of the ingots upon the bed, and the rate of filling depends upon the teemer using stopper throughout.
Zone "B."—Nozzle, 1½ in. Where the number of ingots per bed is just under the capacity of the ladle, casting at full stream.
Zone "C."—Nozzle, ⅞ in. Where the nozzle size and the capacity of the ingots on the bed balance when casting full stream, the steel tending to freeze slightly on the surface during filling.

Fig. 3.



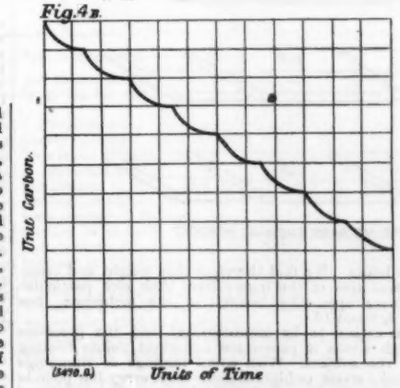
3-ton ingot to be cut up for tire blocks. Total teeming time, 7 minutes. Top half passable, bottom half sure to crack. (Where nozzle full stream exceeds capacity of ingot.)
As shown the time varies for each 10-cwt. portion, and would result in defects according to time taken for each portion, accounting for a number of bad blocks in individual ingots.

Fig. 4A.



Where insufficient CaO or no CaO is used. Showing erratic fall in carbon and consequent variable conditions at finishing.

Fig. 4B.



Where the slag contains throughout the correct CaO per cent. Showing correct bath condition at any period of the boil.

factors, of available silicon and silica of the charge, and that of lime content of the slag, are duly considered and worked to. The slag or refining medium of the process is almost purely a product of the metals, metalloids, and their oxidation during melting and working, and as a consequence it is liable to vary somewhat according to the constituents of the charge and the time requisite to reduce the mass to the molten state. Consistent and reliable results therefore would not accrue, unless some basis is aimed at, to fulfil the functions most desirable. The fact that material is made and passes specification, ignoring the above, is not argument against its adoption. Standardisation is surely essential where so much depends upon the personal element of the workman. Material of just as good quality can be made with only moderate percentages of pig-iron in the charge, providing the ruling factors are fully appreciated; also, the use of high percentages of pig-iron does not necessarily overcome the difficulty of over-oxidisation. Fig. 6 shows a charge illustrative of the effect of great excess of oxide present. The charge consisted of 20 per cent. pig-iron, containing 2 per cent. silicon, and 80 per cent. scrap (including 10 per cent. poor steel turnings). No added slag.

As the diagram (Fig. 6) indicates, the heat worked badly and with a poor slag throughout. The example is given as an exaggerated case of what I refer to, sufficiently bad indeed as to govern its relegating to the scrap-heap. Between such a case as this and ideal casts, however, I maintain there is a long range, productive of doubtful results, though not sufficiently bad to reveal their gravity, until the ingot has been further manipulated. The shortage of pig-iron, and the necessity of drawing from the dump scrap-heap, point to the advisability of adopting some means of control of regular melting. Works possessing unlimited supply of good scrap are not so badly placed as those dependent upon any possible outside source of supply.

Dr. McCance, in his criticism of my paper of May, 1917, was of the opinion that charges possessing some of the properties of the instance given in Fig. 6 were melted cold or slowly, and that quick hot melting would overcome the evil. The charge in question was charged and melted in 6½ hours, which I believe is equal to any other practice in this country for similar size heats, viz., 40 tons. Fig. 6 amply illustrates the possibility of residual "oxides" and one origin of slag inclusions. No ore was used, sufficient oxide being present at the initial stage to more than remove the carbon contained. The big losses in the added finishing materials and the slag composition speak for themselves. I, of course admit that this particular heat required a heavy dose of ferro-silicon or high silicon pig-iron to overcome partly the abnormal conditions prevailing. This again confirms the necessity for due consideration of available silicon and silica in the charge.

There is still some difference of opinion about the use of such basic material as CaO or MgO in the acid open-hearth process, as well as the quantity to add and the periods at which such additions should be made. From results obtained, I contend that 8 per cent. to 10 per cent. in the case of CaO, and rather less where MgO is used, say, 6 per cent. to 8 per cent. are productive of best results. MgO appears to be keener in its functions than CaO. The effect in each case, however, I believe to be similar. The periods to add were given in the May paper, also some of the reasons why.

The principal aim of the use of CaO is not to thin the slag. As the diagrams show, it is a decided advantage to add the main portion of the CaO any time after boiling or even at melting, excepting, of course, the occurrence of some other abnormal condition preventing its use.

Fig. 2.

		MINUTES				AVERAGE
A	TIME EACH INGOT	1½	2	2½	3	10%
	DEFECTS AT MILL	20%	10%	5%	3%	
B	TIME EACH INGOT	2	2½	3	3½	5%
	DEFECTS AT MILL	10%	5%	3%	2%	
C	TIME EACH INGOT	3	3½	4	4½	1%
	DEFECTS AT MILL	2	1		BARELY CRACK	

Fig. 2. Showing yield of sound steel free from "cracks" in rolling. To be read with Fig. 1.

Fig. 5. TO SHOW RELATIONSHIP BETWEEN MN YIELD INTO THE STEEL, & THE PERCENTAGE OF CaO IN THE SLAG. ALL VARYING FACTORS OF COURSE BEING CONSIDERED.

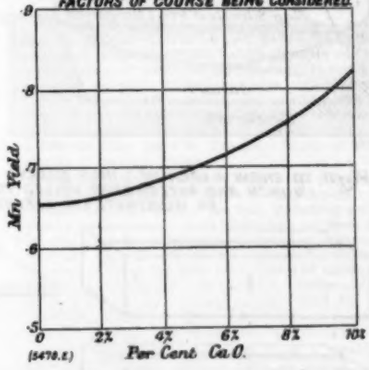
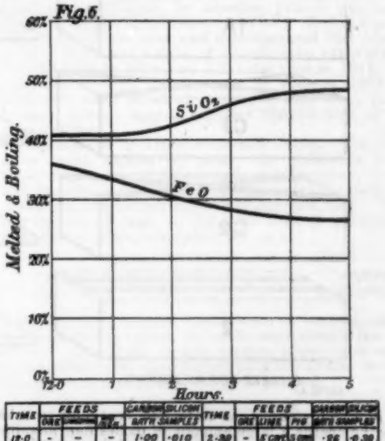


Fig. 6.



TIME	FEEDS			CARBON	SILICON	TIME	FEEDS			CARBON	SILICON
	ORE	LIME	PIG	BATH SAMPLES			ORE	LIME	PIG	BATH SAMPLED	
12·0	-	-	-	1·00	·010	2·30	-	5 CWT	5 CWT	·26	·0·30
12·30	-	-	-	·90	·010	3·0	-	-	-	·21	·0·50
1·0	-	-	5 CWT.	·70	·018	3·30	-	-	-	·17	·0·27
1·30	-	-	5 CWT.	·55	·025	4·0	-	-	-	·17	·0·30
2·0	-	5 CWT	5 CWT.	·37	·035	4·30	-	-	-	·17	-

(5470.F)

Finishing added in bath: FeMn in bath 5 minutes. Theoretically: carbon, 0.15; silicon, 0.15; manganese, 1.10. Practically: carbon, 0.06; silicon, 0.10; manganese, 0.63.
To show bad case of over-oxidised charge during melting. Also conditions subsequently and analyses of steel, &c.

The accepted benefit of the use of CaO at the end of the process confirms my argument as to its values early on. The functions of CaO are:—

1. To enable the FeO present in the slag to react upon the carbon in the bath, by virtue of its intimacy, physically, due to the perfect state of flux the slag assumes.

2. Whether the charge is just melted, boiling, or at any stage, the addition of CaO immediately effects the composition of the slag in similar degrees and tends to remove excess oxides.

3. That the point contended of slag alteration, and the

immediate decrease of FeO in the slag, produce a more absorbent medium for any extraneous matter present in the steel.

4. That CaO is not added to thin the slag.

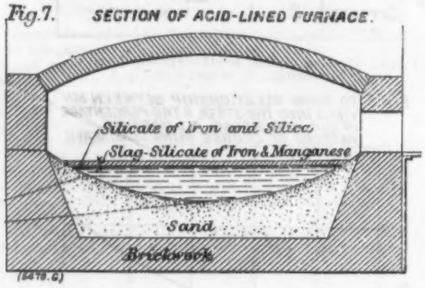
The elimination of any element or compound impurity from the metal into the slag or flux of almost any metallurgical refining process depends upon :—

(A) Temperature.

(B) The receptivity of such slag or flux for such impurity.

Furthermore, the last traces of impurity are usually most difficult of removal. Consider for a moment, that in the case of particles of included matter in the steel, the loss of defective material through this cause is, comparatively speaking, only a very small proportion by weight. In the case of the acid open-hearth also let us consider that we are trying to remove traces of compounds somewhat similarly constituted chemically, to the envelope by which the molten metal is surrounded. Reference is made here to the sectional diagram of the acid open-hearth bath (Fig. 7). When new the hearth proper is composed, or should be composed, of semi-fused SiO_2 plus small percentages of oxides of alumina and iron. This assumes before charging the appearance of an almost white semi-glassy mass. In this condition

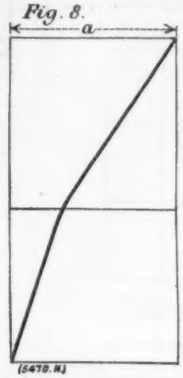
Fig. 7. SECTION OF ACID-LINED FURNACE.



it is in a highly absorbent state, and continues to take from the charge a large amount of oxides (not metallic matter) until the bottom becomes satisfied or completely impregnated. By this means the hearth becomes a most important source of influence upon the working of the steel and its ultimate composition, and possesses some relationship to certain classes of defects. There is a stage, usually after the first few heats, when the hearth, satisfied with oxides, reverses to some degree the action, relieving minute particles of non-metallic matter which are taken into the steel. The elimination of any such matter can only be effected through the absorbing properties of the slag, at least in so far as furnace operations are concerned. The composition of the slag, and its physical state, must therefore be so constituted as to aim at this desired and necessary form.

Thus far I have dealt with oxides formed during melting or introduced during boiling, and their possible elimination, by means of the slag influence upon them. Under good conditions, however, an appreciable residual amount not removable in the furnace remains in the steel. Commercially we may have steels termed free from the evil, which in point of fact are not. The amount present in such instances is insufficient to affect tests, or the speed of solidification and size of the ingots and the requirements of the manufactured article do not reveal but tend to hide its presence. Small ingots retain the inclusion disseminated fairly evenly throughout the mass, the chilling effect of the mould preventing liquation of the particles. In the case of large ingots the reverse is experienced. A cheese tire ingot, for example, is subject to what I may term direct chilling solidification, or in other words, the mould influence outweighs the heat above freezing-point possessed by the steel in the mould. Taking such an ingot, weighing only a few hundredweights, and comparing it with one weighing about 25 tons, the actual time of solidification in the former case is in minutes, and in the latter many hours. We find therefore that weight and cross-sectional area of the ingots have their own particular influences upon the locality of the inclusions. See Figs. 8, 9 and 10.

Fig. 8.



Cheese-tire ingot, where the entire ingot is solidified by direct cooling of the mould itself. Inclusions finely disseminated.

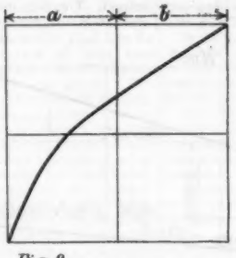
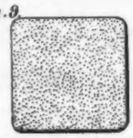


Fig. 9.



10-in. square ingot, where a large portion of the ingot is "chilled." Inclusions fairly well distributed.

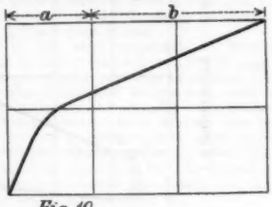


Fig. 10.

14-in. square ingot, where about one-third of the ingot is "chilled." The "dotted" area in small bars from the ingots show where the inclusions would be located.

Figs. 8, 9 and 10. "a" shows proportion of the ingot solidified by the "chilling" effect of the mould; "b" shows proportion of the ingot solidified by "radiation." The curves show rate of solidification of the whole ingot. The slag particles are fairly evenly distributed in the "chilled" area, but are found more "locally" in the more slowly solidified steel.

Fig. 11. TO SHOW 4-INCH BY 3-INCH BILLETS CUT WHERE MARKED TO A DEPTH OF ½-INCH AND AFTERWARDS ROLLED, TO SHOW HOW DEFECT DEVELOPS. TO ILLUSTRATE THE EFFECT OF ROKEY BILLETS.

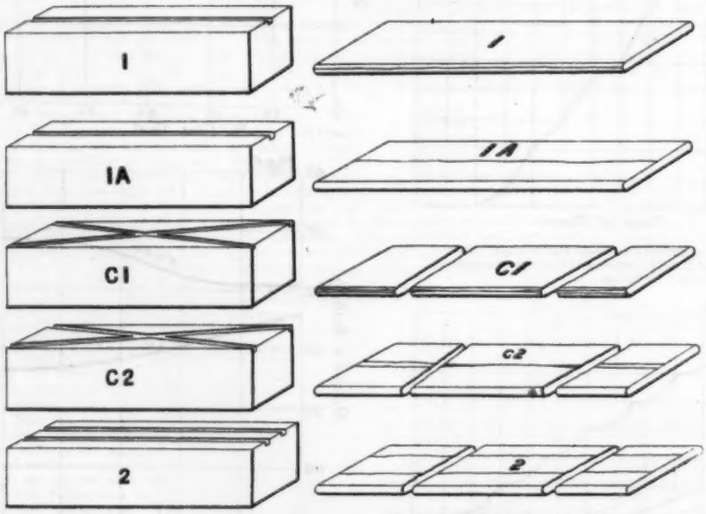
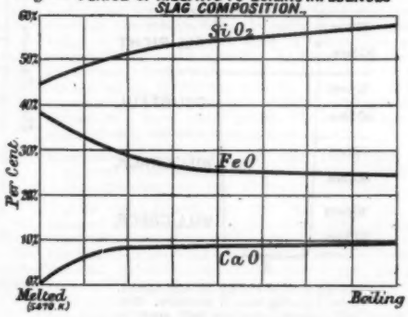


Fig. 12. SHOWING HOW ADDITION OF CaO DURING PERIOD OF MELTING TO BOILING INFLUENCES SLAG COMPOSITION.



The article to be manufactured and the processes through which it passes are important points bearing upon the subject. With small forgings or stampings in special steels, or highest grade wire, every few pounds of the whole cast is put practically to close physical and other tests, whilst close machining also tends to reveal defects of minute proportions yet sufficient to cause rejection and failure. The inevitable residual slag inclusions found in the ingot and not removable in the furnace present a difficulty worthy of overcoming. To cast the steel in such a manner as to bring the whole in direct contact with some absorbent flux either in the ladle or a secondary ladle, or in the mould, would possibly prove a successful course. Some essential basic fluxes have great affinity for oxides and silicates of iron, manganese, and aluminium, and the contact of the steel with such during the process of casting would certainly be at the least partially successful. It will be often noted, when casting steel by the tun-dish method, that a good deal of extraneous matter rises to the surface of the steel, due to giving up of matter previously held in suspension. The experiments made in the direction named do not warrant more on the subject at present, but certainly give incentive to more investigation.

Basic Open-Hearth Steel, with some Reference to the Electric Process.

Introductory.

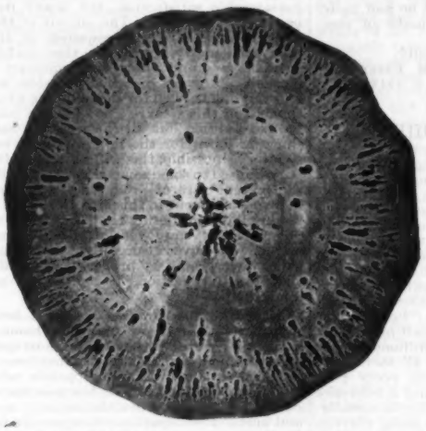
During the last three years particularly the growth of the electric process of steel making has been nothing less than phenomenal. No one can dispute that the electric process can produce material easily, which in our acid or basic open-hearth would present considerable difficulty.

Of the many claims of the process, freedom from slag or gases has been most prominent. Correct manipulation will most probably justify this claim, but material is sometimes made which, as regards defect, rivals that by any other process. This defective material has been obtained naturally by wrong manipulation and the non-fulfilment of the principles of sound steel-making, and the fault is not attributable therefore to the process.

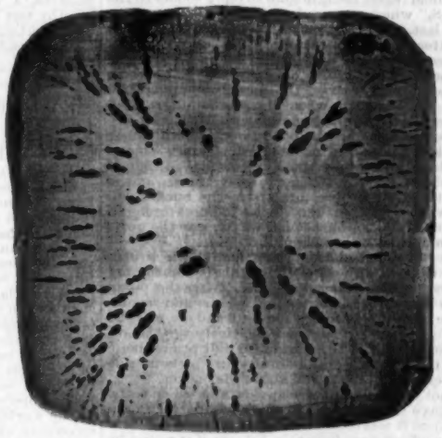
The defects from which our basic open-hearth steel suffers are due to similar causes as in the case of the electric process. That high-grade material can be made and is made on the basic hearth is undoubtedly correct. Numbers of otherwise practical men couple thoughts of basic steel with the inseparable phosphate slag, which has perhaps been the main obstruction to producing sound high-grade steel. A good many of the claims of the electric basic furnace apply equally as well to basic open-hearth. The main difference in the two processes, ignoring certain mechanical advantages, is the quick supply of local intense heat in the electric furnace. The physical state and chemical composition of the slag in a basic open-hearth process are the main essentials for success. Giving full appreciation to the valuable work done in this country by Mr. E. H. Saniter and other eminent metallurgists, in working out the process as a formidable competitor of the acid open-hearth, little has been done in establishing its position in the industry as far as special and alloy steels are concerned. The failure of the material is not due to the process, but to incomplete exploitation or faulty manipulation.

If the basic open-hearth process is worked with highly phosphoric raw material direct, and with one slag only, it will not prove to be a serious rival of the other processes in the special steel trades. I may be told that the particular advantage is in its adaptability to the use of almost any class of raw material. I maintain that the load (if I may use the term) of the working of the charge is in ratio to the phosphorus content; and that the means necessary for its removal constitute the first source of danger in the way of poor material. Charges relatively high in phosphorus have to be more than liberally dosed with oxide to effect elimination of that element, leaving behind in the steel the undesirable oxides producing the defect as shown in photograph No. 1, page 37.

DEFECTS IN STEEL INGOTS.

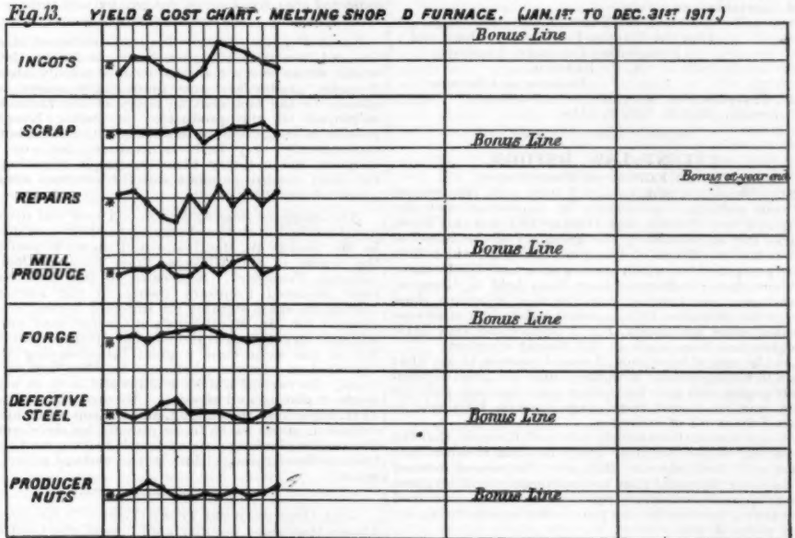


No 1.—Section of Basic O.H. Steel. Made for Tires. Showing unsoundness due to unsuitable conditions of slag and bath at tapping.



No. 2.—Section of Electric Steel Ingot, showing (1) Blowholes (wild steel). (2) Lappiness, or folds in the ingot. (3) Inc uded unfluxed fireclay.

Fig.13. YIELD & COST CHART. MELTING SHOP D FURNACE. (JAN.1ST TO DEC.31ST 1917.)



To bring closer relationship between melting shop, mill and forge, and bring home defective material. Also to formulate a bonus system to increase output and quality, giving the steelmakers interest beyond the ingot.

Output.—From time to time we hear a good deal about the rapidity of continental open-hearth practice as compared with our British works, and the big difference in output certainly looks formidable. One of the chief hindrances to progress in output is due to limitation of output practised by some firms. This does not compare well with the opposite aim or conduce to efficiency. We can find furnaces limited to six charges per week, the theory being that more charges would mean "hurriedly worked" and bad steel. The fact that a neighbouring firm could tap, say, 11 casts per week with sound results should be, but is not a sufficiently forcible, argument against the stand taken. Until the big difference existing in output is broken down our tonnage will not rise to that of continental works.

THE COAL TRADE AFTER THE WAR.

THE Departmental Committee on the Coal Trade has now issued its report, signed on April 25, 1917, and published on June 28, 1918. It is explained that several late corrections have been made, and that a further report may be necessary. The report is signed by Adam Nimmo (chairman), A. E. Bowen, Newton Dunn, F. J. Jones, Arthur F. Pease, Sir D. M. Stevenson, Ridley Warham, Mr. J. U. Smith acted as secretary.

The Committee does not give figures of capital employed in the industry, such as are given in the engineering reports. The following table shows the gross annual production in tons for the United Kingdom :—

Annual Production of Coal.

	Tons.
1905	236,111,150
1910	264,417,588
1913	287,411,869
1916	256,348,000
1927 (estimated)	318,412,000

Production per Man.—In 1906 this was 360 tons; the yearly average, 1906–10, 340 tons; 1913, 321 tons. This is per person (men and boys) employed underground. A remarkable fact stated in the report, in comparing production in 1914 with 1916, is that the number of persons employed decreased 13·7 per cent., while the tons produced decreased only 8·4 per cent. The comparison is between the first six months in each year, and, therefore, between pre-war and war conditions. The tonnage is the Government return of coal brought to the surface, and includes a proportion of dirt, stone, &c.

Cost of Production.—The wages cost is given as two-thirds to three-fourths of the whole cost. The rise in wages from 1909 to 1913 was 15 per cent. to 20 per cent. in some districts, and during the war a further 40 per cent. Other costs have advanced still more during the war.

Export Trade.—An exhaustive series of tables is given for various destinations. The proportion of the total output exported was one-fourth, or including bunkering coal shipped for use in foreign-going ships, one-third. The principal groups of destinations of our exported coal (not including coke and manufactured fuel) were :—

British Exports of Coal, 1913.

Ports in	Tons.
Europe and Mediterranean ...	35,768,000
North Sea	29,005,000
African	886,000
India and East...	612,000
America, North and Central ...	189,000
South America	6,940,000
Total	73,400,000

The value (f.o.b.) of the total exports of coal, coke and manufactured fuel (1913) was 53,660,000*l.*; more than 10 per cent. of the total value of all our exports.

German Competition.—The Committee's recommendation in favour of free export to all, including enemy countries, is based chiefly on the position of Germany as a coal and coke exporter, not so much in traffic with this country, as with Allied countries. Germany produces (1913) 187,000,000 tons of coal, and imports 10,000,000 tons, of which 9,000,000 tons are from this country. The German export of coke is considerable; in 1913, 2,338,000 tons went to France. Much of the German export is railway borne.

Recommendations.—The Committee recommend that all restrictions on the export of coal should be removed as soon as possible after the war, including restriction on export to Germany. Also that alien subjects should not be excluded from owning or working minerals in this country, but should do so subject to licence; these licences to be given only to subjects of nations allowing a similar privilege to our subjects. Other recommendations refer to way-leaves, surface land for plant and railways, revision of plant, provision of miners' houses, consular service, and statistical information.

Coke.—The report does not show a working out of the coke problem, with a view to seeing whether we could supply France, or whether France can supply herself if her lost provinces are won back. No full separate statement of our coke and manufactured fuel trade is given. The total weight of British coke exported was 906,053 tons in 1910, and 1,235,000 tons in 1913. The complete German total export of coke in 1913 was 6,330,000 tons, of which 4,027,000 tons went to our present Allies. Austria supplied 316,000 tons of coke to our Allies.

Requirements of Allied Preference Policy.—The report gives rough figures of what the preference policy requirements are. If Allied trade with Germany, Austria and Turkey ceases (there are no figures for Bulgaria), our Allies will lose certain supplies of coal and coke. When our exports of these, on the 1913 basis, to enemies are diverted to Allies, the deficit will be :—

	Tons.
Coal shortage	1,700,000
Coke ,, ...	3,800,000

Britain and America would have to make good the shortage for some years. It can be made good in the form of coal, coke, steel, or coke-making plant—any or all, as our Allies wish, until industries settle down. At least four times as much is now being made good.

OXIDISABLE CONSTITUENTS OF COAL.—In recent researches on the constitution of coal, pyridine is frequently used as solvent in order to separate the various constituents of the coal. As the process may favour the absorption by the coal or by the pyridine of oxygen, unless the air be excluded, Messrs. J. I. Graham and J. Hill (Transactions, North of England Institution of Mining Engineers, vol. 65, pages 37 to 54) have experimented on coal from the Barnsley soft seam in an atmosphere of nitrogen, at reduced pressure (60 mm. of mercury) and a temperature of 40 deg. C. The washed extract, distilled in vacuo, formed a brown fusible powder, insoluble in ammonia, partly soluble in caustic soda and in chloroform; this extract made up about 12 per cent. of the original coal. Whilst the black coke-like residue retained not only pyridine tenaciously, but also oxygen, it was found by experimenting in air and in an atmosphere containing 90 per cent. of oxygen, that the extract had little affinity for oxygen. Thus contrary to the often expressed opinion, it is apparently not the extract of resinous substances which is responsible for the absorption by the coal of oxygen, but the insoluble residue of substances of the cellulose type. The researches are being continued to clear up this somewhat unexpected result which may not altogether be explicable by the exclusion of air during the extraction.

AIR PUMPS.

TO THE EDITOR OF ENGINEERING.

SIR,—I much regret being unable to reply sooner to the letter by "S," which appeared on page 468 of your issue of April 26 last. It is a pleasure to me to see my two previous letters have been of interest.

The power required to drive an air pump varies enormously; for instance, in the old type of pump, which has foot and bucket valves, the power required when starting is greater than when the vacuum has been formed, there being so much more air to discharge.

In the Edwards' pump the conditions are still worse as the bucket has to be forced down against a comparatively high pressure, in some cases equal to that of the atmosphere, thereby tending to increase it, at the same time the absolute pressure above the bucket will be very low, in fact that due to the temperature. Of course immediately the bucket begins to clear the ports air rushes in and places it in equilibrium.

The power required during these first down strokes is far more than at any other time; this is a point my father always impressed on designers. After the pump has made a few strokes the amount of air and consequently the pressure becomes reduced and in a short time the power required becomes relatively very small. By far the safest plan is to provide for full atmospheric pressure in the condenser and an absolute pressure due to the temperature in the barrel above the bucket.

I regret not being able to give any data based on tests. My father gave these records to the Edwards Air Pump Syndicate when it was formed, subsequently the manager died and the offices were burnt, so I doubt if it would be possible for me to obtain such data as I should care to put forward. There must be many large engineering firms who have reliable data and if they would kindly place them at the disposal of your readers I am sure many of the latter would be grateful. In my letter dealing with air leaks I omitted to point out that by stopping them the power of the engine is increased and the load on the air pump reduced.

In reply to the inquiry by "S," the air pump barrel was inside the air pump casing and the indicator placed as close as possible. Of course the shorter the pipe the better, still, what I have recorded remains almost incredible. The foregoing does not refer to Edwards' air pumps working under jet conditions.

I am, Sir, yours faithfully,
CHRISTOPHER F. EDWARDS.

3, Castle-street, Berkhamsted, Herts.

TESTING AIR COMPRESSORS.

TO THE EDITOR OF ENGINEERING.

SIR,—As one who has had considerable experience in testing air compressors I would like if you can give me a little space to make some remarks on the test results of a 4,000-cub. ft. Belliss and Morcom air compressor, the report of which was published in your issue of the 5th inst. The report gives us some very excellent and interesting figures, but the method by which these tests were carried out is not one that inspires reliance on the results.

It is a difficult matter to obtain an accurate pump up test on such a large machine in the makers' works, for the simple reason there is very little chance of obtaining a receiver of sufficient capacity to enable a proper test to be carried out. Take a single receiver of a fair size, with short connecting pipes to give about 300 cub. ft. capacity, then this compressor, running at full speed, would fill that receiver with air at 80 lb. per square inch in about 25 seconds, which is far too short a time in which to take accurate readings, and the test results would have no value.

I have known of one prominent firm of air compressor makers who have endeavoured to get over this trouble by running a similar size compressor at half speed, say about 100 r.p.m., and supposing that the test in question was carried out in a similar manner, the time taken to fill the receiver would be about 1 minute, which is still too short a time to obtain reliable figures, and the results may vary 10 per cent. above or below the rated output of the compressor. In addition it is, of course, as anyone will understand, greatly to the advantage of the compressor to be tested at a speed of a little less than half full speed as regards output of air, and especially as regards the brake horse-power required to compress that air. The first stage indicator card taken while the machine is running at full speed and full load will indicate more truly the maximum quantity of air which the compressor will deal with.

With regard to the no-load test it is described how, to enable the compressor to be started up with the 50 brake horse-power motor, an air pump was connected to the compressor discharge and the air thus exhausted from the air cylinder, when the motor was then able to overcome the starting resistance. When the speed had reached the normal, the air pump was cut out and the receiver air, at 80 lb. per square inch, was introduced to the discharge side of compressor, thus producing the normal no-load conditions. No mention is made of how the clearance volume air, which under normal no-load conditions would be at a pressure of about 80 lb. per square inch in the second-stage cylinder, was got into the machine, as obviously the receiver air would be held by the second-stage discharge valves. This point seems to have been overlooked, although it may have been that despite the tightness of all the valves the leakage from atmosphere past the piston-rod packings would ultimately, after a long run, gather in the cylinder and so produce nearly the exact condition of a compressor on the "governor."

The author of the report considers it worth while mentioning that the temperature of the air at the compressor discharge throughout the 3¼ hours no-load test was 100 deg. F. Why should it be any more, seeing that little or no air had been discharged from the compressor during all the 3¼ hours' run! To conclude my remarks, I would say that for such a laborious and lengthy test the results do not seem to be at all worthy of special note, and similar results could be had under similar conditions from any first-class make of compressor.

Yours faithfully,
M. FAIRLEY.

7, Polwarth-crescent, Edinburgh, July 9, 1918.

THE DISINFECTION OF SHIPS.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the paragraph on page 708 of your issue of June 21, on the "New Disinfection Process for Ships," and in which the Clayton process is mentioned, you state that "SO_2 cannot be applied to certain cargoes such as grain, wheat, oil seeds, &c., because it deprives them of their germinating power." We would respectfully point out, however, that it is a mistake to suppose that the Clayton process cannot be applied to cargoes such as you mention, as the gas used for rat destruction is not of a sufficiently high percentage to interfere in any way with the germinating power of grain; besides, it is as well to remember that only a very small proportion of the grain imported is used for seed. Millions of tons of wheat, barley, maize and oil seeds of all sorts have been subjected to Clayton gas in practically every port of the world, and this is still going on, and a reference to owners whose vessels are fitted with Clayton installations, and to the port health authorities using Clayton fumigating and disinfecting plants, would confirm this. The only cargoes that it is really impossible to treat by the Clayton process are bananas, oranges, and fresh fruits and vegetables, as a rule.

Yours, &c.
(For the Clayton Fire Extinguishing and Disinfecting Company, Limited),
A. L. RESSICH,
Manager and Secretary.

22, Craven-street, Northumberland-avenue, London, W.C. 2, July 9, 1918.

PATENT LAW REFORM.

TO THE EDITOR OF ENGINEERING.

SIR,—Some six months ago I dealt with this matter in your columns; principally in connection with the proposed new Patents and Designs Bill and the Trade Marks Bill introduced by the President of the Board of Trade into the House of Commons last year, which Bills were postponed but which are now once more on the *tapis*.

Since then Conferences have been held in Glasgow, Manchester and London, with the view of having these somewhat ridiculous Bills amended in details or otherwise treated more drastically, but I understand very little progress has been made in the desired direction.

At the risk of repetition, I would venture to say that I am in full agreement with the Editor of a great London daily paper who gave his opinion some time ago that the only way to amend these undemocratic Bills was to amend them out of existence.

We are now authoritatively informed, however, that the President of the Board of Trade has laid it down that these most unsatisfactory Bills are to be pressed forward at an early date and that no countenance will be given to any special moratorium legislation for the loss sustained by existing patents having practically lapsed during the four years of war.

I am of the opinion that it would be simply wasted energy to do anything with these Bills but have them strongly opposed in the House of Commons, more especially seeing it was intimated in the Press only the other day that one of the questions to be dealt with by the Imperial Conference now sitting in London was the assimilation of the Laws of the Patents and Designs and Trade Marks in the United Kingdom and our great Dominions.

Since 1883 we have actually had in this country at least eight Patent Acts and Amendments, whereas the present Patent System of the United States was adopted some 87 years ago and to-day it still remains the most democratic and progressive patent system in the world; therefore, why cannot we have a system similar so far as possible to that of the United States for the British Empire, instead of having Acts for patents and designs and for trade marks more or less in imitation of German and continental systems forced upon us? The question again comes to be, why should the Board of Trade be all powerful in the matter of patents and designs and trade marks, when it has surely quite enough to do when it has the control of railways, ship-building, shipping, lighthouses, steam boilers, petrol control, and so on? The importance of invention, patents and designs, and trade marks should be as great in Great Britain as it is in the United States, where an entirely separate department has full control of these.

Might I venture to suggest that it will be far better to wait till the war is over than attempt to amend Bills that in my opinion are altogether wrong in principle and in details, and which ought to be scrapped root and branch.

Yours, &c.,
JAMES KEITH.

London, June 29, 1918.

THE LATE MR. GEORGE WALLER WILLCOCKS.—We regret to have to announce the death, which occurred on the 7th inst., at his residence, Roehampton, S.W., of Mr. George Waller Willcocks, C.B., who was formerly Chief Engineering Inspector at the Local Government Board. Mr. Willcocks was 70 years of age; he was, since 1880, a member of the Institution of Civil Engineers.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—A very substantial increase in the production of steel for munitions is noted with considerable satisfaction, the heavy demand for shell bars being well met. The output of the sectional and constructional material required in the shipyards is on a particularly large scale, thus enabling shipbuilders to make a grand effort to counteract the submarine menace. In every direction ceaseless activity prevails, and this augurs well for the holidays which commence at the end of this week. The old-time policy of finishing up and sending out all the work on hand prior to the shutting down for the holidays, still holds good, and, so far as is possible, this will be done. Export continues to be limited to some small shipments to France, although the present rate of production would quite warrant a little development in this direction. All this is the more remarkable considering that the recent comb-out of the younger men employed in the steel-making industry might well have disorganised existing arrangements. When everything is properly adjusted again to suit the altered conditions it looks as if much extension might be possible.

Malleable Iron Trade.—Although better supplies of raw material are now coming to hand, malleable iron makers have still to combat a shortage of labour, and unless skilled men can be recalled from the Army it is difficult to know how the orders which have been "booked" during the past few months are to be turned out. The output, notwithstanding, is very extensive, and in the steel departments especially some good orders for France are being pushed forward with much despatch, but beyond this there is no other overseas trade, the home demand absorbing all the remaining tonnage. It is expected that fixed prices for export will shortly come into force.

Scotch Pig-Iron Trade.—Pig-iron continues in active demand, hematite being much sought for by the steel works where every ton produced is rapidly absorbed. Foundry grades are now increasingly scarce, owing mainly to the fact that so many of the furnaces are employed on the production of basic. Everything possible is being diverted to work of national importance, consequently very little is available for any other purpose, the ordinary home consumer receiving only the most meagre supplies and the overseas consumer practically nothing at all.

New Shipyard Staging Design.—A new and distinctly novel method of shipyard staging has just been designed by Mr. George W. MacIlvaine and shown in position at the works of the Glasgow Steel Roofing Company, Limited, Possilpark. Something in this direction has been rendered necessary owing to the scarcity of Norwegian spars suitable for shipyard berths, and it is claimed for Mr. MacIlvaine's invention that not only will it be an economical and efficient substitute for timber but at the same time a great labour-saving device. Operated on a fixed steel channel base the framing slides to suit the various widths of ships and to fit in with the work of plating and riveting. Riveted channel pillars, 45 ft. high, form the staging, and the top is arranged for extension pieces of 10 ft. to provide for developments. The timber planking is fitted on self-locking steel channel thwarts fixed through slots in the vertical pillars, 2 ft. apart.

GOLD ORES FROM THE IVORY COAST.—It has long been known that some peculiar gold ores of the Gold Coast, Africa, are tellurides. But their composition had not been determined, and as the ore is very finely disseminated and quite invisible sometimes, a more exact study is desirable in order to settle on the right method of treatment. In the metallic part of some ores which F. Roux (*Comptes Rendus*, April 28, 1918, page 645) collected in 1910 and 1911, at Kokundo, he found 8·6 per cent. of gold, together with bismuth (48 per cent.), copper (1·8 per cent.), tellurium (37·5 per cent.), some sulphur and traces of silver; this ore was an auriferous tridymite. On the amalgamation table the crushed ore left a grey impalpable powder, although the gold was not discernible in the ore. In some washed ore from Poreson Roux discovered 77 per cent. and even 93 per cent. of gold, with several per cent. of silver; there was little tellurium, but a considerable proportion of bismuth.

AGRICULTURAL AND DAIRY MACHINES ORDER.—As the above Order (see page 19 *ante*) appears to have been misunderstood in several respects, the Ministry of Munitions considers it advisable to emphasise the following points in connection with it:—(1) The Order applies to articles manufactured in the United Kingdom only, and does not apply to imported articles, the prices of which are separately controlled. No permit is necessary for the sale of such articles. (2) Permits are required only by persons desiring to sell any agricultural or dairy machine or implement which they have not purchased direct from the actual manufacturer. Sub-agents, for instance, must apply for permits to sell articles obtained by them from agents or wholesale dealers. Farmers or users purchasing machinery or implements for their own use do not require a permit for such purchases. (3) The Order applies to any new machine, implement, vehicle, or other article or part thereof, designed or adapted or commonly used for either agricultural or dairy purposes. (4) The Order does not apply to any second-hand agricultural or dairy machine, implement, vehicle, or other article. (5) The prices referred to in Clause 2 of the Order, are not "fixed" prices but "maximum" prices, and any person is entitled to sell below them.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Handicaps on Industry.—The industrial world is being considerably hampered by the spread of influenza, and during the past week, decidedly irregular conditions of employment have occurred. Concern was already being occasioned by the drastic demands on labour by the military service recruiting authorities. So considerably are the latest withdrawals affecting the works, that an appeal for greater consideration for local industrial needs has been made to the authorities. It is felt that unless the desired indulgence is forthcoming production is going to be very seriously handicapped.

Cutlery and Plate Trade.—Notwithstanding the steadily decreasing number of employees, there is no abatement in the demands on the cutlery trade. In most of the works, production is going on at top pressure. Big quantities of table cutlery and razors are being turned out. Large orders for the latter are being executed for the American forces, the equipment of whom, by the way, is bringing a big volume of trade to Sheffield. The silver and electro-plate trade is threatened by the most recent recruiting measures, and steps are being taken to secure protection for this already very much denuded industry.

Iron and Steel.—Activity has receded during the past week, not because of any marked decline in the calls for materials, but in consequence of the disturbance of employment through recruiting and illness among the workers. In some places pronounced slackness has been a feature, and there have been instances where departments have been brought to a standstill. The rolling mills would appear to have suffered badly, and the dislocation of trade in those departments has naturally affected other branches, which are dependent upon them. There has been an increase in the demand for certain classes of steel, but generally speaking, the situation remains the same as it was a week ago.

South Yorkshire Coal.—Here, as everywhere else, the ravages of influenza have caused disorganisation, and the position, which was far from being satisfactory, has been aggravated in consequence. Operations at many pits have been interrupted, and at the moment everything points to the conditions during the next few months being of a particularly difficult character. The pressure for best steams is continued by all home consumers. A considerable proportion is going away to allied countries, and small quantities to neutrals. Contract account is absorbing all the available supplies of cobbles nuts and slacks. Nuts are very keenly sought after for munitions works. The supply of household coal is markedly short. Cokes are scarce at maximum figures. Quotations:—Best branch handpicked, 25*s.* 6*d.* to 26*s.* 6*d.*; Barnsley best Silkstone, 25*s.* 6*d.* to 26*s.*; Derbyshire best brights, 23*s.* 6*d.* to 24*s.* 6*d.*; Derbyshire house coal, 21*s.* to 22*s.*; best large nuts, 21*s.* to 22*s.*; small nuts, 20*s.* to 21*s.*; Yorkshire hards, 21*s.* to 22*s.*; Derbyshire hards, 20*s.* 3*d.* to 21*s.* 3*d.*; best slacks, 16*s.* 6*d.* to 17*s.*; seconds, 15*s.* 6*d.* to 16*s.*; smalls, 11*s.* 6*d.* to 12*s.* 6*d.*

GAS EXHALATION FROM POTASSIUM SALT DEPOSITS.—The natural potassium salt deposits at Stassfurt and elsewhere slowly exhale various gases, the occurrence of some of which is ascribed to the effect of radium salts, probably deposited together with the other salts. That helium is in these gases was first shown by Professor Erdmann, of Halle, and confirmed by Professor Strutt. The radium may also account for the observation of hydrogen and of carbon monoxide (from water and carbon dioxide decomposed by X-rays); methane has also been found in the gases, which are copious in some districts after heavy rains, possibly because the water expels the gases which had accumulated in the pores of the dolomite.

WILLING'S PRESS GUIDE.—We have received from Messrs. James Willing, Limited, advertising contractors and publishers, 125, Strand, W.C. 2, a copy of their Press Guide for 1918, the forty-fifth year of publication. It contains an alphabetical list of the newspapers and periodicals issued in the United Kingdom, giving the name of the publication, stating when first issued, the day of issue, price, address of publishers and address of London representative. A second list gives the publications classified according to trades, interests, professions, subjects, &c.; whilst other lists are classifications according to towns and counties. Indications are also included concerning Colonial and foreign journals, together with general information covering the publishing trade. The book is issued at the price of 1*s.*

LOW MANGANESE, HIGH PHOSPHORUS SPIEGELEISEN FROM SLAGS.—A process for the manufacture of spiegeleisen, based on the recovery of manganese in the slag or flush cinder produced from open-hearth steel furnaces is referred to in *The Iron Age*, New York. The flush cinder and tapping cinder contain large amounts of manganese as oxide of manganese. One object of the process is the production of a low manganese spiegel that is adapted for many uses and particularly for making special steels, as for example a steel intended for rolling into sheets, black plate and tin plate. The flush cinder is smelted or reduced in the blast furnace. The burden is reduced in the same manner as when manganese ores are employed in making ferro-manganese and spiegeleisen. Approximately 85 per cent. of the manganese in the flush cinder and tapping cinder is claimed as recovered as spiegel. A low manganese, high phosphorus spiegel forming an alloy which is peculiarly adapted for use in the manufacture of steel for sheets and tin plate is obtained.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Business in Cleveland pig-iron is rather quieter. Demand for foundry quality has relaxed considerably owing to Scotland taking little or none, due to holidays north of the Tweed, but the whole of the output of this description continues to be promptly taken up. Output of foundry kind has been reduced, an undue proportion of forge quality having recently been produced owing to furnaces working somewhat irregularly. Thus there is a plentiful supply of forge, and makers thereof are offering to sell freely for either early or forward delivery. The influenza epidemic has interfered with delivery of pig-iron. Foreign trade in Cleveland iron is fairly good, and shipments to France are well maintained. For home consumption, No. 3, No. 4 foundry and No. 4 forge are all quoted 95*s.*, and No. 1 is 99*s.*; and for shipment to the Allies, No. 3 and the lower qualities are 114*s.*, and No. 1 is 119*s.*

Hematite Iron.—Output of hematite is passing promptly into consumption as it is produced, and no opportunity is afforded to accumulate stock, but continued careful control of distribution permits all absolute needs of home customers to be dealt with adequately, and enables essential supplies to be despatched to our Allies. The improved facilities for distribution are well maintained, and deliveries both by rail and steamer are on quite a good scale. Consumption of basic iron ore and scrap in the manufacture of steel is becoming larger, and this assists the hematite situation to no small extent, the general condition of which may be described as healthy. Nos. 1, 2 and 3 East Coast hematite are 122*s.* 6*d.* for home use, and 147*s.* 6*d.* for export to France and Italy.

Manufactured Iron and Steel.—There is great and ever increasing activity in finished iron and steel. The present huge output is insufficient altogether to meet demands, and it is gratifying to hear of satisfactory progress being made with important extensions to steel plants which are yielding proportionate increase in the aggregate make. Government requirements and shipyard needs still absorb production, so that ordinary commercial business is little heard of. Quotations for all descriptions are very strong. To home customers common iron bars are 13*l.* 17*s.* 6*d.*; best bars, 14*l.* 5*s.*; best best bars, 14*l.* 12*s.* 6*d.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 17*s.* 6*d.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel hoops, 17*l.* 10*s.*; and heavy steel rails, 10*l.* 17*s.* 6*d.*; whilst for export, prices, though not fixed, may be given as approximately 40*s.* to 60*s.* above home quotations.

Fire at Middlesbrough Ironworks.—A fire at the extensive Newport Ironworks, Middlesbrough, would doubtless have assumed enormous dimensions but for the timely and untiring services of the Middlesbrough Fire Brigade. Two motor fire engines were quickly on the scene and with commendable expedition a copious supply of water was playing on the conflagration and surrounding buildings and plant. In a couple of hours the flames had been subdued and prevented spreading to valuable adjoining property.

Coke.—Scarcity of coke is still very pronounced, but under the conditions prevailing, the absolute requirements of the blast furnaces are being dealt with satisfactorily. The heavy demand for neutrals meets with little or no success. Average blast-furnace quality is 33*s.* at the ovens, and low phosphorus sort 35*s.* 6*d.* at the ovens.

Ironstone Miners' Wages.—A conference of Cleveland ironstone mineowners and miners' representatives met this week to consider the question of wages for the ensuing quarter. No official statement as to the outcome of the meeting was issued, but it is understood that a settlement was not reached.

ELECTRIC POWER TRANSMISSION FOR STAVANGER, NORWAY.—The town of Stavanger has acquired water-power rights in two places which, fully developed, will yield about 200,000 kilowatts; that would be at the rate of 6 kw. per inhabitant. Owing to the indirect war troubles building operations are practically suspended at the new works, however, and electric energy is at present being supplied by the Flöeli Electrosmeltowaerk near Lysefjord. The transmission line from these works has a length of 26.5 km. and crosses the Hölefjord in a span of nearly 1 mile. In the mountains the three copper cables, each of 50 sq. mm. cross section for currents of 55,000 volts, rest on wooden masts 7.5 m. high, generally 130 m. apart, but with some spans of 250 m. On each of the two sides of the Hölefjord three iron masts have been erected, the bases of these towers being on the one side at an altitude of 133 m., on the other side at 89 m., about high-water level; the towers themselves have a height of 7 m., and they are 15 m. apart; the three cables each of 16 mm. diameter consist of 19 steel wires. The distance between the two sides is 1,332 m., but the cables sag considerably, of course, and are in the middle only about 40 m. above high-water level; for high-masted ships there is a good shipway near the higher bank. The span mentioned is exceeded in the transmission line of the Shawinigan Power Company which crosses the St. Lawrence River, there 1,500 m. (4,920 ft.) wide, by three cables for current of 100,000 volts; the steel towers between which the cables are suspended have a height of 150 m. (500 ft.) and the minimum height of the cables above the river is 48 m. (157 ft.).

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—The shortage in the supply of coal is now again become really acute, mainly on account of the reduced outputs at the collieries, and this serious diminution in the output is due largely, if not mainly, to the prevalence of the influenza epidemic among the miners. The numbers of absentees are very considerable, and colliery companies are quite unable to meet the demands. The shortage affects all classes, with the exception of lower grade steam coals, and there is not a surplusage even of these sorts. House and gas descriptions are much short of the current needs, and the same remark also applies to patent fuel and coke. The supply of pitwood has not been so plentiful the last few days, although the shortage is not such as to cause any appreciable inconvenience so far.

Newport.—The market for Monmouthshire coals is just now very difficult. There is an exceptionally strong demand, but the output seems to be getting less instead of better, and the pressure is more pronounced than ever. Unfortunately there does not seem much hope for any great improvement in the immediate future, and salesmen are therefore placed in quite an embarrassing position.

The Colliery Examiners' Trouble.—A further effort was made on Monday to settle the long-standing trouble between the South Wales coalowners and the lower-grade colliery officials who are members of the South Wales Colliery Examiners' Association. A joint meeting of representatives of the coalowners and of the men concerned was held at the Engineers' Institute, Cardiff, but while no definite agreement was come to it is not likely that there will be a recrudescence of the dispute to the extent which led to the strike of November of last year. When the terms offered by the coalowners (which are stated to mean an improvement in the conditions of 75 per cent. of the examiners) were subsequently reported to a conference of examiners the following resolution, which indicates the general feeling which prevailed, was adopted: "That while agreeing to the proposals of the owners regarding the remuneration of the colliery examiners as a means to arrive at a uniform wage rate, it be an instruction to our side of the Joint Board to continue negotiations with a view to retaining all existing privileges at the collieries; and, therefore, this matter will be discussed by the various lodges next Saturday, and accordingly a special conference will be held in the near future."

Coal Rationing Scheme for South Wales.—Mr. Finlay A. Gibson, the Secretary of the District Coal and Coke Supplies Committee for South Wales and Monmouthshire, has addressed to local public authorities the conditions governing the supply of house coal during the three months ending next September. He states that it is anticipated that the new Household Fuel and Lighting Order, although applicable as and from July 1, cannot take practical effect for at least three months, and the arrangements now made for that period by the local Supplies Committee have received the approval of the Controller of Coal Mines. They provide that colliery companies must supply merchants with 30 per cent. less in July and in August than in the corresponding months in 1917, and in September next 25 per cent. less than in September of last year. The deliveries of merchants for retail purposes are cut down in equal proportions, and merchants are under obligations, as far as possible, to supply the same householders as in the corresponding periods of 1917. If they have been drawing supplies from districts other than South Wales and Monmouthshire they will continue to be entitled to the monthly quantities allocated to them at the latter end of 1917, subject to the monthly reductions of 30 per cent. for July and August, and 25 per cent. for September. The maximum deliveries are those laid down in the Household Fuel and Lighting Order, and it is provided that merchants must not deliver more than 2 tons to any house within a period of two months, or basket men or hawkers more than 3 cwt. in any week to the same householder.

THE AUTOMOBILE ASSOCIATION AND MOTOR UNION.—On the 10th inst., at the Savoy Hotel, London, the annual general meeting of the Automobile Association and Motor Union was held. Mr. W. Joynson-Hicks, M.P., chairman of the association, presided, and said that with regard to the financial position, they had continued the policy laid down at the time the war commenced, and had built up a large reserve fund. During the past year they had carried down to reserve 24,374*l.* This fund had now reached such a figure that when the war was over no organisation connected with motoring would have such a fighting fund ready to set to work in the interests of motoring as the Automobile Association.

MERCHANT SHIPBUILDING AND NATIONAL SHIPYARDS.—The Secretary of the Admiralty makes the following announcement: The Controller-General of Merchant Shipbuilding has accepted the resignation of Mr. Noel E. Peck from the position of Director of Shipbuilding at the National Yards. Mr. Peck's resignation follows on the recent announcement that Lord Pirrie has assumed personal responsibility for the running of the national shipyards. This resignation leaves Lord Pirrie free to build up the staff and organisation of the yards on the lines on which he proposes to work them. Mr. Peck will return to Messrs. Barclay, Curle and Co. and Messrs. Swan, Hunter and Wigham Richardson, of which firms he is a director. His services will thus continue to be put to the fullest use.

TEMPLETS, JIGS AND FIXTURES.

(*For Description, see Page 27.*)

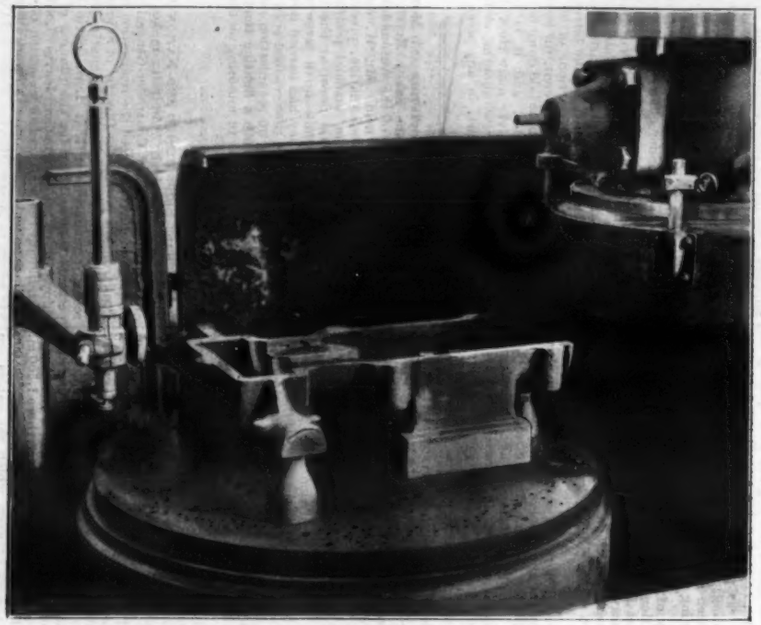


FIG. 278.

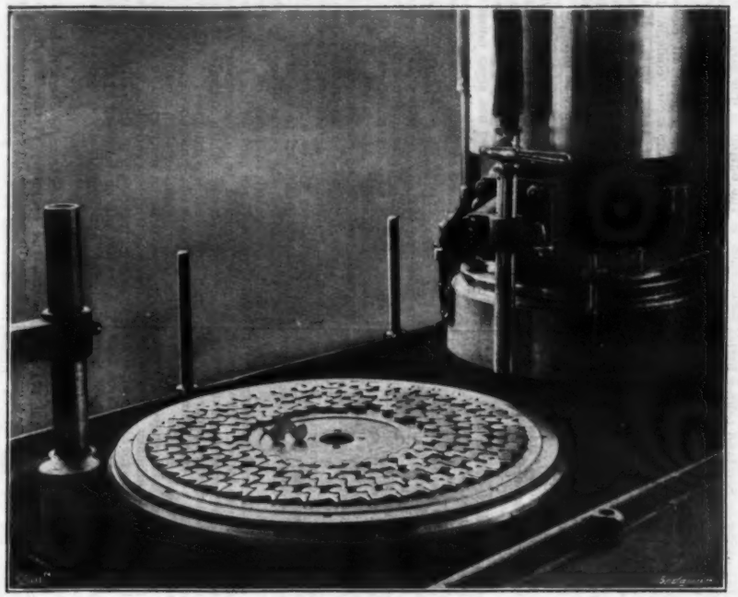


FIG. 281.

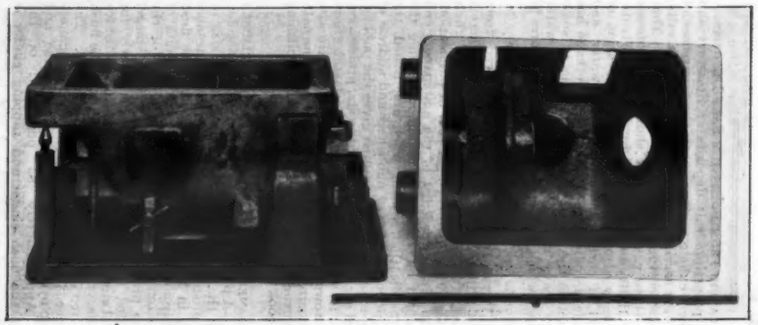


FIG. 279.

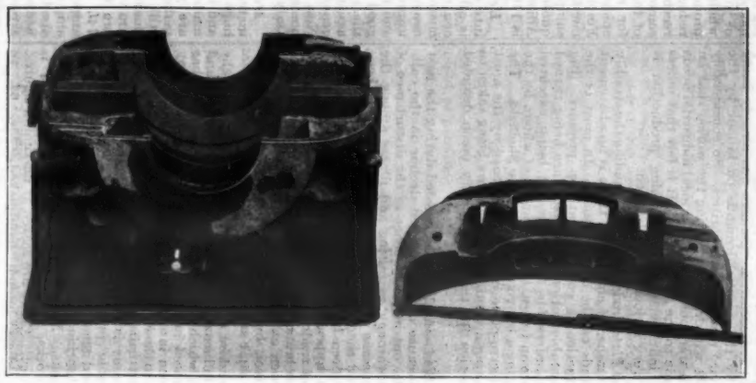


FIG. 280.

FIGS. 278 TO 281. EXAMPLES OF FIXTURES USED ON THE BLANCHARD VERTICAL SURFACE GRINDER; THE BLANCHARD MACHINE COMPANY, CAMBRIDGE, MASS., U.S.A.

LJUNGSTRÖM STEAM TURBINES FOR THE S.S. "WULSTY CASTLE."

CONSTRUCTED BY THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, LOUGHBOROUGH.

(*For Description, see Page 30.*)

Fig. 5.

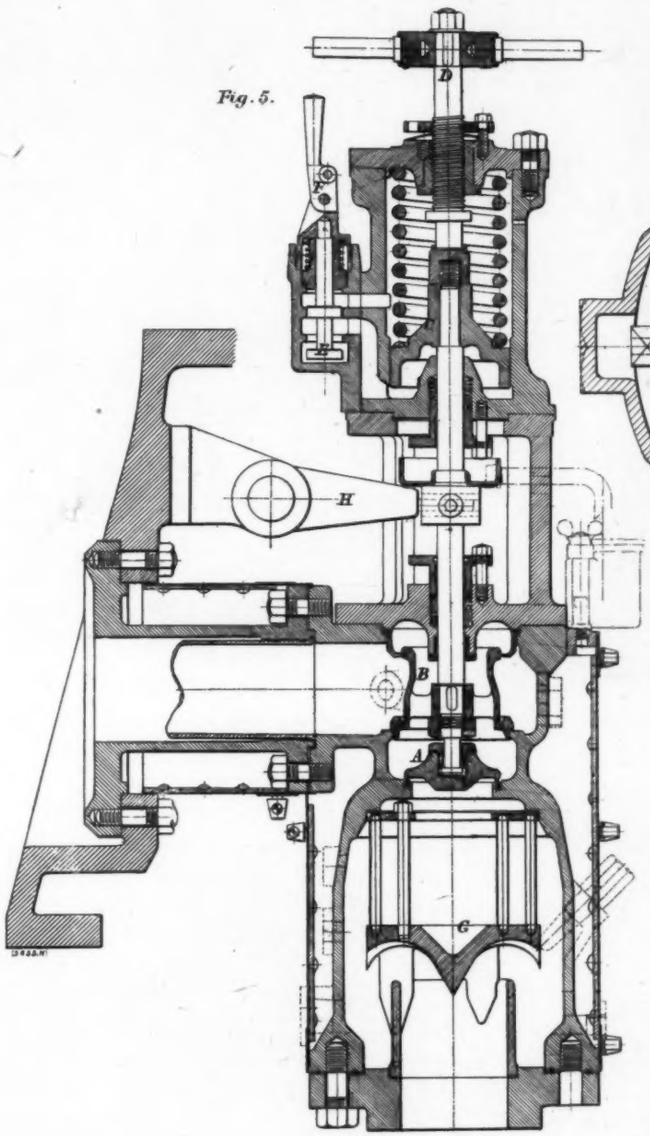


Fig. 7.

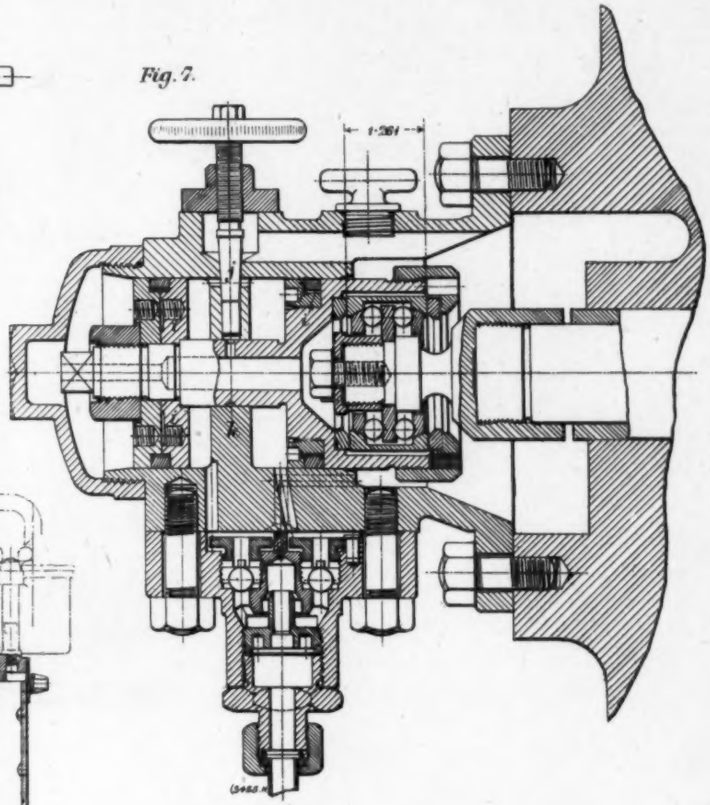


Fig. 8.

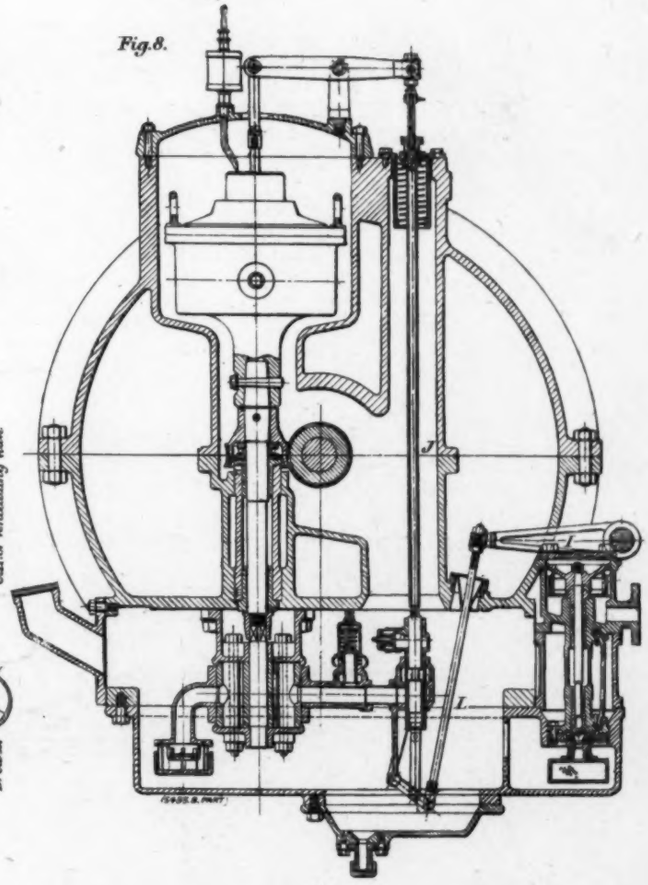
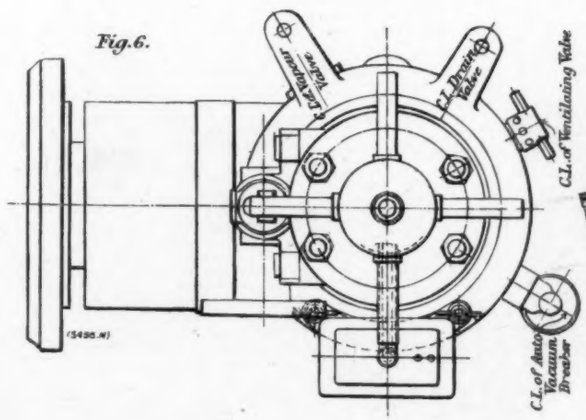


Fig. 6.



(*To face page 30.*)

LJUNGSTRÖM RADIAL-FLOW STEAM TURBINE

CONSTRUCTED BY THE BRUSH ELECTRICAL ENGINEERING

(For Description, Page 3)

Fig. 1.

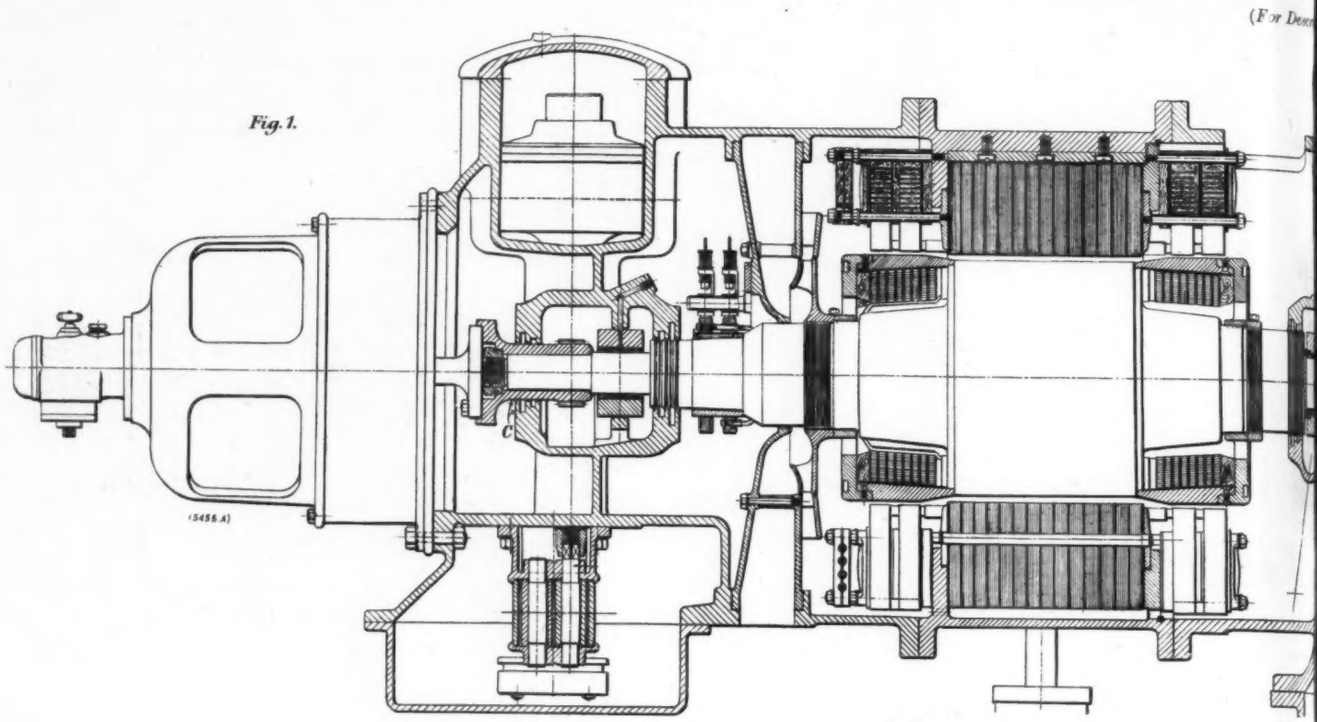
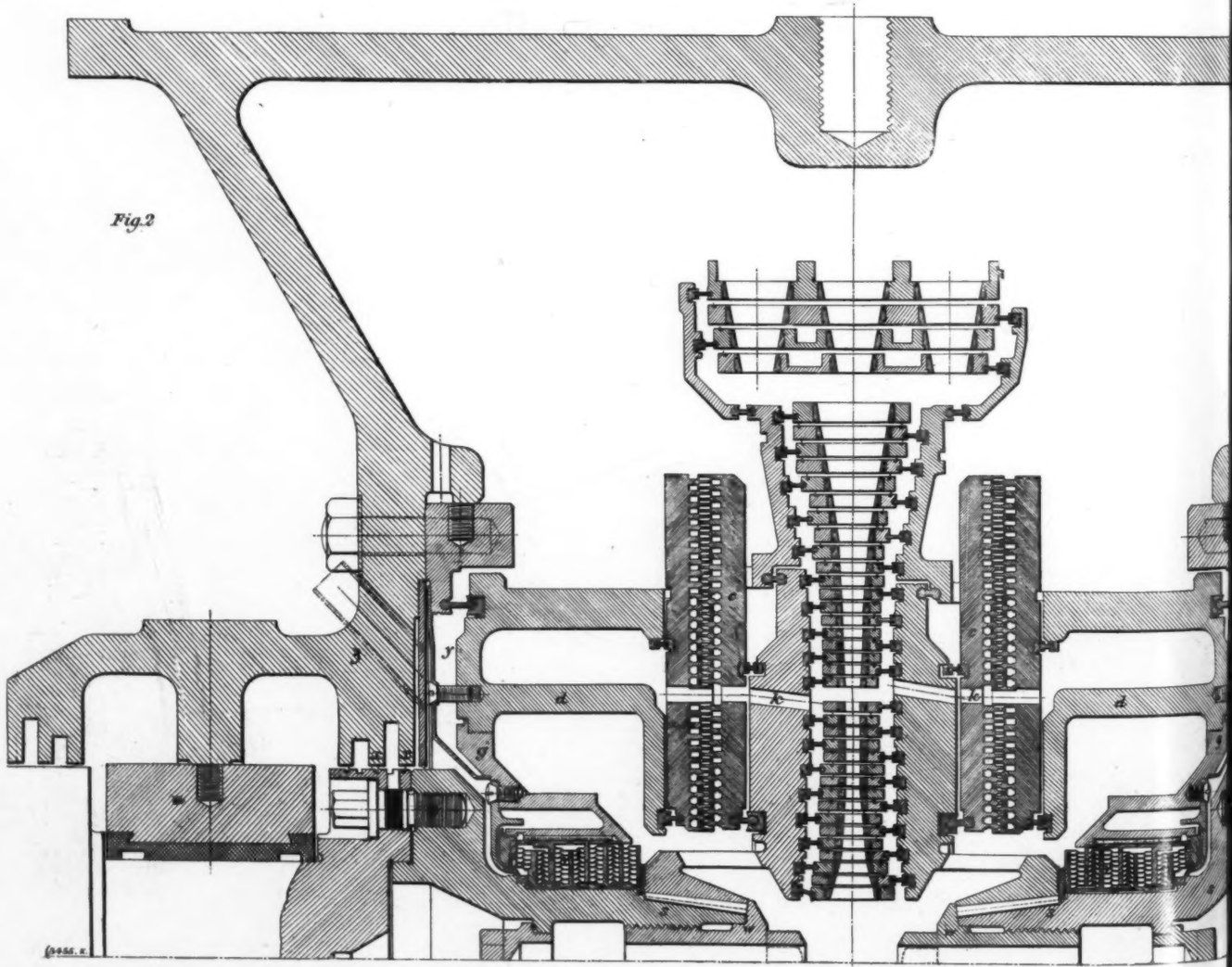


Fig. 2



AMRBINE FOR S.S. "WULSTY CASTLE."

CAL ERING COMPANY, LIMITED, LOUGHBOROUGH.

(See Page 30.)

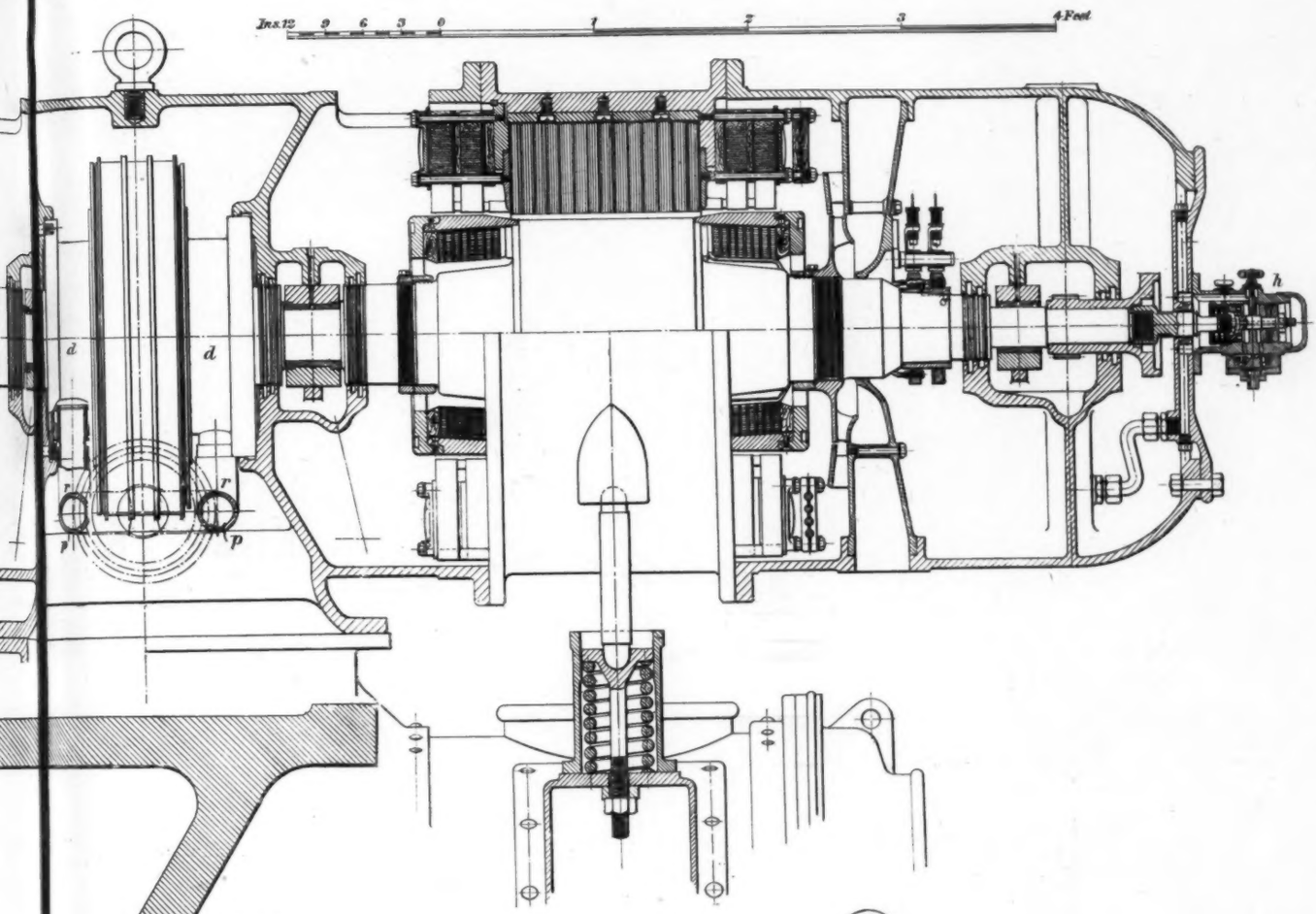


Fig. 4.

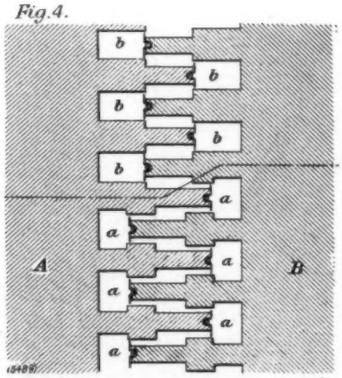
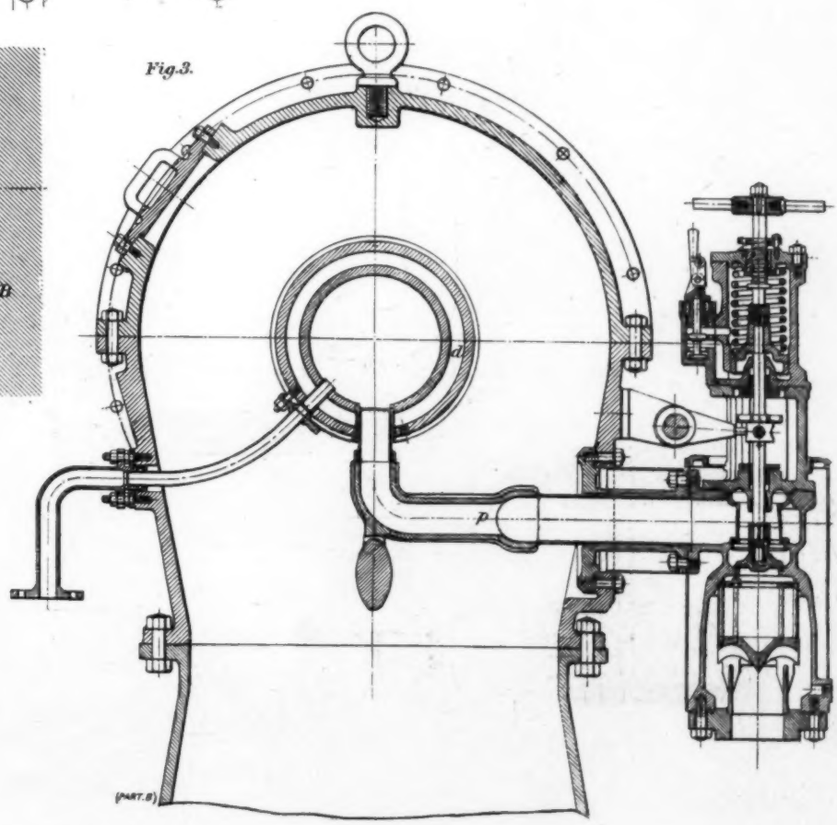
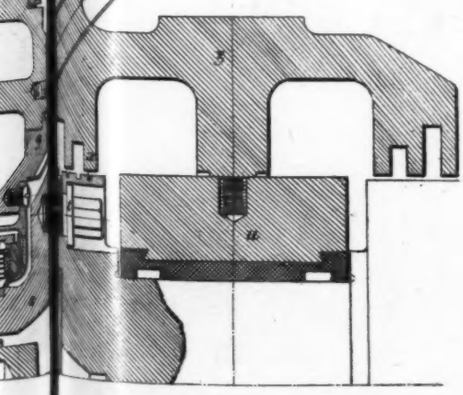


Fig. 3.

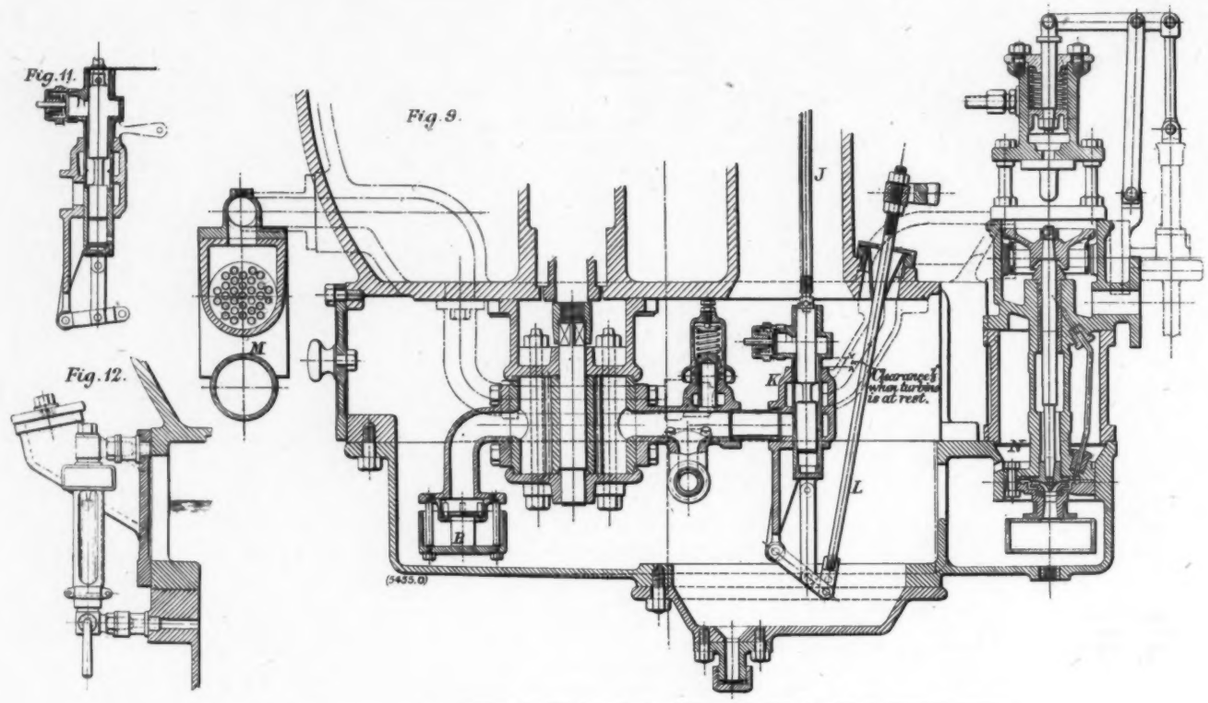


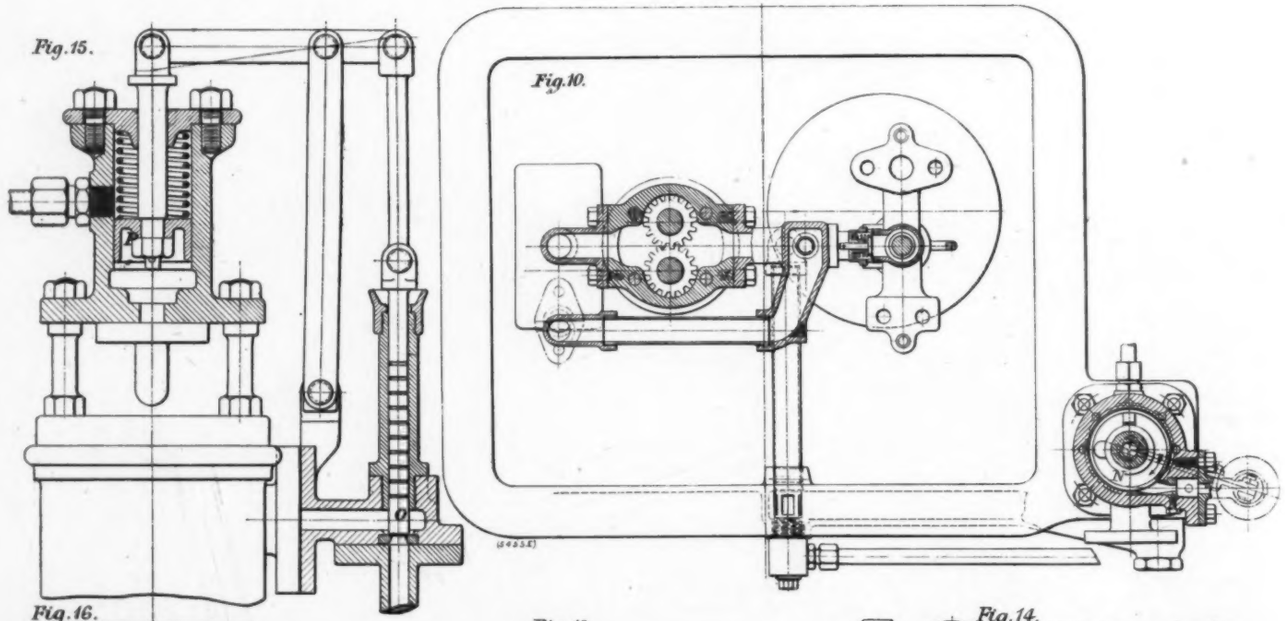


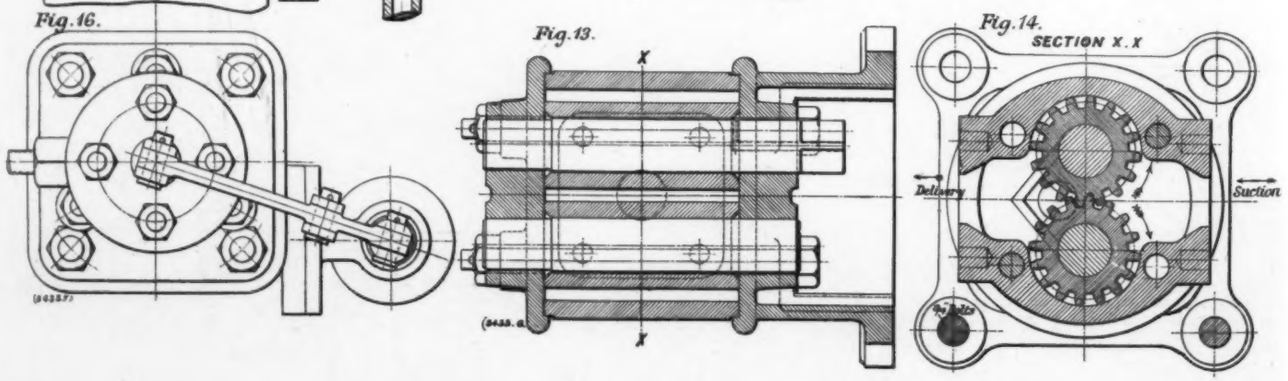
LJUNGSTRÖM STEAM TURBINES FOR THE S.S. "WULSTY CASTLE."

CONSTRUCTED BY THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, LOUGHBOROUGH.

(*For Description, see Page* 30.)







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TELEPHONE NUMBERS—3663 and 8598 GERRARD.

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With One Two-Page Plate and Two One-Page Plates of the LJUNGSTRÖM STEAM TURBINES FOR THE S.S. "WULSTY CASTLE."

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal further from 8d. to 9d. per copy. This increase dates from and includes the issue of Friday, March 1, 1918. The change will not apply to unexpired subscriptions. The revised rates for new subscriptions are given in the adjoining column.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents after June 24th will not have copies for chance customers, therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

ENGINEERING.

FRIDAY, JULY 12, 1918.

LATENT INVENTIVE CAPACITY IN OUR WORKSHOPS.

ONE of the main features in the Whitley Report when dealing with the subject of Works Committees, is the proposal to use the knowledge and experience of our workers to the end of improving in all ways, the efficiency of the methods of production. To quote from the Whitley Report on Industrial Councils, paragraph 16—among the questions with which it is suggested that the National Councils should deal or allocate to District Councils or Works Committees the following may be selected for special mention: (i) The better utilisation of the practical knowledge and experience of the workpeople. (ix) The provision of facilities for the full consideration and utilisation of inventions and improvements designed by workpeople, and for the adequate safeguarding of the rights of the designers of such improvements.

It will be readily admitted that the necessary powers of observation and deduction, together with the requisite experience are sufficiently present among the workers in our factories to achieve considerable results in the direction indicated, and it may well be that in the past this source of gain to industry has to some extent remained untapped and undeveloped. The condition engendered by the war and the large number of new problems that have called for immediate solution have given rise to a state of progressiveness, with the result that the necessity of giving to new ideas much greater consideration than in the past is now fully realised, so that, provided such ideas are forthcoming they will be more generally welcomed than hitherto. The extent to which new ideas from the workers may be expected to be made available in the future cannot altogether be estimated from past experience, as the effects of the war, already indicated, have changed the general outlook and have engendered inception and encouraged reception.

Recent improvements in technical education and the rapid strides in this direction confidently anticipated in the near future will contribute towards the creation of a stimulus. So much is by way of qualification. The main issue clearly is to give to all the fullest possible opportunities for the expression of such ideas, which expression will bring direct and substantial advantages not only by way of the ventilation of ideas so provided but also in the application to industry of the useful among the suggestions and improvements put forward.

This does not represent a new thought. Many firms for a considerable number of years have had in operation in their works, suggestion schemes with these broad aims in view and, whilst the past results have depended in great measure upon the manner in which the details of the scheme have been worked out, and the general spirit or atmosphere which has prevailed in the shop in question, it must be recorded that the results have been in the main disappointing. The actual details of these schemes for dealing with suggestions vary mainly in respect of the amount of the award offered and the promptitude and care with which the communications from the workers are considered. In the past the number of suggestions put forward has not been sufficiently great to evaluate the award at a figure lower than could be described as generous. Promptitude in dealing with such matters is very essential and delays militate against success. The main differences between various schemes lie in the manner in which the principal factors are interpreted and in the broad-mindedness or otherwise of those responsible for the administration.

There are certain causes which have operated in the past to prevent extension of the benefits of such schemes:—

(*a*) It has been stated that the workers' objection to increased efficiency and greater production, in that unemployment will result, has acted as a deterrent to their putting forward ideas towards improvement in methods and practice. Whilst, in general questions, when dealt with on a mass vote, these sentiments are still too much in evidence, yet, in a matter entirely concerning the individual, this influence, it is felt, is negligible.

(*b*) The suspicion that, whilst an idea or suggestion would be welcomed by the management, yet its transmission will bring ill-will from the direct superior of the worker is a difficulty that will undoubtedly have to be met, even where it is a condition of the scheme that the name of the suggester will not be transmitted to the shop authorities. This feeling has been found to hold so strongly in certain cases that it must be founded on actual experience, although proof is seldom forthcoming, and can only be explained by the incompetence and ignorance of those in authority, which it is to be hoped is rare and will undoubtedly decrease.

(*c*) The third point is the dissatisfaction of the individual with the amount of monetary award granted for the improvement or idea. It is but human that the suggestion should be regarded as having a disproportionately high value in the mind of its creator, who feels sometimes that he is being exploited by his employers in not receiving a very large proportion of the saving which he imagines has accrued from the adoption of his idea. This dissatisfaction may be the cause of a cessation of effort to put forward further suggestions, and is mainly a question of perspective.

These three points are put forward somewhat fully as being directly concerned with the success of all suggestion schemes, and therefore bearing upon the main subject of the utilisation of the inventive capacity of workers in factories whether by suggestion schemes, works committees or the like.

It will be interesting, however, with the reservations already put forward, to examine the working in the past of such suggestion schemes with a view to forecasting the extent of the future benefits to be derived from this source of invention. As already stated, the results have been disappointing, not only as regards quantity but also quality. Inventions are exceptionally rare. In this connection it might be pointed out that lack of confidence in the management for fair dealing in regard to inventions would preclude their being transmitted, whatever the scheme may be. As already quoted, the Whitley Report holds that the formation of the prescribed councils, and the suggested means for safeguarding rights, &c., will go far to remedy this difficulty. The general nature of suggestions received goes to prove, however, that inventive capacity is exceptionally rare. The question of perpetual motion periodically recurs.

At the inauguration of such suggestion schemes in any shop, a certain number of suggestions may be received that are quite irrelevant. In time this percentage diminishes. The great majority of ideas are concerned with details in regard to design of plant or product and method of manufacture, and generally, alternatives to the methods in vogue rather than innovations are put forward. Such alternatives are frequently the cause of effecting a saving or an increase of efficiency by calling attention to an unsatisfactory state of affairs in complimentary operations and contributory methods. In general, therefore, the advantage accruing from suggestions received concerns the proof afforded of wastage and inefficiency rather than in respect of the particular method of improvement specifically

prescribed. Such suggestions are, of course, most valuable.

Another type of suggestion includes ideas which may form part of the ordinary routine duty of the transmitter, as, for instance, the devising of ways and means for meeting certain contingencies, when this is part of the individual's ordinary work, and as such, cannot be dealt with directly under the suggestion scheme.

Due regard must also be had to the possibility of workers exploiting the suggestion scheme and utilising it merely as a means of augmenting earnings as, for instance, suggestions having little bearing on the plant or work in question which are directly copied from technical periodicals or hand books and transmitted in the form of original ideas. Apart from this instance there are also those whose design is most obviously the gaining of the awards and not the improvement of efficiency. Such suggestions may generally be readily and easily distinguished by the scanty and threadbare nature of the communications put forward often with almost persistent regularity, but such suggestions should always be welcome, however poor in material, provided the outcome is a sure improvement on present practice.

The manner in which the foregoing amongst many other points are dealt with, and the feeling that exists after these more or less initial difficulties have been overcome, will largely determine the ultimate success of the scheme, one essential being that increased efficiency is worth attaining, and that every effort in this direction, however slight, is worthy of encouragement and is regarded as an earnest of genuine desire.

As possibly of value, the following figures may be given: The number of suggestions received may be expected to be from 6 or 8, even as high as 20 or 25 per annum per 100 workers, and awards will be paid on from 35 per cent. to 40 per cent. with an average of 35 per cent. of the total numbers of suggestions received. A percentage of 35 per cent. will only be reached if a generous estimate is made of the results to be obtained from the suggestions as put forward. The number of ideas received and the percentage upon which awards are paid will vary also according to the nature of the work undertaken, since certain classes of tradesmen are notably more prone than others to conceive new ideas and more capable of transmitting them. Pleasant surprises, however, in the unexpected source of some of the best suggestions will be one of the most gratifying features of the working of such a scheme and will contribute part of the return for the work involved, as, for instance, the large amount of investigation required prior to passing judgment on the merits of suggestions with a view to assessing awards.

Certain individuals will undoubtedly bring themselves to the favourable notice of the management through the medium of a suggestion scheme, and their claims to promotion will naturally be favourably considered when opportunities serve. The exact knowledge of latent ability so gained is one of the valuable advantages derived from schemes of this kind.

To indicate the nature of the suggestions received in a certain works, the following classification is made: (*a*) Improvements in systems of organisation and methods apart from (*b*), 22 per cent.; (*b*) improvements in plant, equipment of tools, &c., 70 per cent.; (*c*) improvements in design of products, 5 per cent.; (*d*) inventions, 1 per cent.; (*e*) irrelevant ideas, 2 per cent.

This classification has reference merely to the type of suggestions put forward, and does not indicate the proportion of awards which, as already stated, average about 35 per cent. of the total number received; nor does it indicate the nature of the improvements effected, which may sometimes differ from the ideas transmitted. For instance, a suggested improvement in plant might call for an alteration in design of product as the correct solution to the state of affairs indicated in the suggestion, and conversely; also a suggestion dealing with improvement of plant might simply point to faulty organisation. In conclusion, such schemes are undoubtedly valuable and are strongly to be encouraged. The results may seem disappointing, yet they are cumulative in effect, and in time will go to assist in building up good feeling and tend continuously towards increased efficiency, although experience goes to show that the exaggerated claims sometimes made on behalf of the workers in respect of inventive capacity and latent genius cannot be substantiated by facts. When in time the results of the operation of the various Government Invention Boards at present in force come to be published—which Boards serve the community as a suggestion scheme does the workshop—they will probably be found to substantiate the conclusions put forward above.

SPEED OF CONSTRUCTION AND TOTAL PRODUCTION OF SHIPPING.

WE have recently discussed the spread of the competitive spirit among our shipyards and their workers (induced largely by the publication of statistics of tonnage completed and tonnage sunk, recently adopted by the authorities), which found immediate expression in the riveting trade by the setting up of records (see page 613 of our last volume). It was then indicated that, however satisfactory this expression of keenness might be, yet greater increase of output would accrue if this same spirit of emulation, and pride in performance, could be invoked in the other classes of workers whose efforts contribute largely towards production of tonnage. This object is finding expression in the efforts now being made to attain the completion of ships within record periods, or to accomplish a definite portion of the work of construction within a minimum number of working days. The stages of work selected for this purpose have been, so far, those from the laying of the keel to the launch, and from the launch to completion. In this connection the following performances have been recorded as meritorious. In the United States of America, the collier named Tuckahoe, was launched within a month of the laying of the keel—the exact time was given as 27 days, 2 hours, 43 minutes. Again, in the United States of America, it is claimed that a torpedo boat was launched within 16 working days of the laying of the keel, no other particulars being given; and, thirdly, the completion in Great Britain of a 5,000-tons deadweight cargo carrier within 19 days of the launch. These figures are being widely published, and go to show that the spirit of competition is spreading, but unfortunately, sufficient details to justify a full expression of opinion as to the relative and individual merits of the various performances, are lacking.

In connection with the Tuckahoe, a photograph has been published which shows that the ship was in a very advanced stage towards completion at the launch, so enhancing the value of this record. The extent to which "fabrication" was adopted is not stated, but it must certainly have been considerable. Again, the amount of labour available must have been very large, and, no doubt, was fully utilised by working three shifts per 24 hours. In the case of the torpedo boat, the vessel in question must have been much smaller than is generally inferred in this country by this term. A torpedo boat is very much smaller than a torpedo boat destroyer. The British figures quoted are in no way exceptional, especially if the ship was in an advanced stage of completion at the date of launch in connection particularly with the deck gear, the shafting, piping and valves, &c. These considerations point to the necessity of defining the state of work on the ship at the commencement and completion of a phase of construction under review, and, of course, the main features of the type of vessel involved, should be known. It must be pointed out that these records are not in any way necessarily the measure of the efficiency of production which, for the purpose of this comparison, may be defined as the maximum output in a given time per unit of available labour. It is assumed that the shipbuilding yard in question is concentrating on that design and quality of product for which it is most suited in respect of plant and personnel, without which records would be difficult to achieve, and except in so far as this most important factor is concerned, design need not enter into the present consideration.

It may generally be assumed that the number of workers belonging to the various trades required to complete the type of ship in view, are in suitable proportion to the total available. It will be obvious that, if a great number of workers are crowded on to, and retained, on one ship, the time required for one stage of the construction, or for the complete construction, will be relatively small, provided the intensity of work is reasonably high, the material supply satisfactory, and the appliances are adequate in type and number for the purpose. It is highly probable, however, that much higher overall efficiency of production could be achieved, under similar circumstances, if the numbers of workers supposedly concentrated on one ship were spread in suitable proportion over two or more ships, and the necessary arrangement made that each trade followed its predecessor at the appropriate time, and then passed without loss of time, to perform the same function in a following and similar ship. There is an obvious loss of efficiency when the ships' hulls are completed and require to wait for machinery, or where, conversely, the engines are completed and await the hulls. The standardisation of design and the concentration of one yard on one class of hulls or engines are powerful aids towards co-ordination of efforts between the various departments, since, with the experience and the exact knowledge rapidly gained by repetition work, the time required to be allotted to each trade for the completion of its particular portion of the total work of construction is accurately known. In the case of the American records, it is probable that the number of workers utilised on these contracts was considerably in excess of the number required for maximum overall efficiency, although this procedure may have been justified by the peculiar exigencies of the case, as, for instance, when a particular ship for special duty is most urgently required in minimum time.

It is necessary, generally, to legislate broadly, and important not to accede to panic. The best policy will probably be a compromise between that which may be the most suitable for the present or the immediate future, and that which will give the largest return in the long run. These policies are distinctly dissimilar, and the exact compromise which is required at any time can only be formulated as a result of full knowledge of the estimated ratio between the gain and loss of shipping due to war causes, and the general future situation and conditions, as, for instance, the need of transports, &c. Shipbuilders, under stress of war conditions, are being urged by the authorities in the directions of construction within minimum time and the maximum amount of construction with the available labour, and it is not always possible to resist the pressure brought to bear in these two somewhat conflicting directions.

Although the records published in regard to speed of production do not indicate the efficiency, *i.e.*, the maximum total production per worker over a given period—preferably of considerable length—yet, the tendency is undoubtedly in the right direction, and it is to be hoped that these attempts to create records will increase. If the man-hours could be taken as the standard basis of comparison, provided sufficient data relative to the type of ship were given, a valuable stimulus would be afforded towards greater speed of ship production, giving at the same time an equivalent increase in overall production.

THE BRITISH ASSOCIATION.

ON September 9, 1916, the British Association adjourned at Newcastle to reassemble at Bournemouth in the following year under the presidency of Sir Charles A. Parsons. By March, 1917, the Bournemouth authorities and the Council of the Association had reluctantly come to the conclusion that owing to the difficulties of securing accommodation for the sections and members, and to the restrictions of travelling facilities, the continuous series of meetings, held without interruption since September, 1831, might have to be broken, and in May the Council cancelled the Bournemouth meeting. It was announced at the same time that Bournemouth had renewed its invitation to the Association for some future year, the 1918 meeting having already been fixed for Cardiff* in accordance

* See ENGINEERING, October 27, 1916, page 405.

with the old-established custom of making arrangements for two years in advance. It was resolved that Sir Arthur Evans, the president of the Newcastle meeting, should continue to act as president, and that Sir Charles Parsons should remain president-elect; the general officers—Professor John Perry, treasurer; Professors W. A. Herdman, of Liverpool, and H. H. Turner, of Oxford, general secretaries—were re-elected, *i.e.*, confirmed in their offices. In spring, 1918, the Local Executive Committee at Cardiff regretted to have to inform the Council that a postponement of the visit to Cardiff seemed desirable, and the Council, bowing to the necessity of that decision, in May, cancelled the 1918 meeting, Thus the contemplated eighty-eighth meeting was abandoned like the eighty-seventh.

The decision did not cause surprise, but it was received with universal regret and some disappointment. Though the meetings of the British Association can only take place once a year, many members are as much attached to the Association as they are to the other learned bodies to which they belong. If the Institution of Naval Architects and the Iron and Steel Institute can have their gatherings in London, and if the Society of Chemical Industry can even have a successful annual meeting in the country; if, further, the Conference of the Delegates of Corresponding Societies affiliated to the Association can take place; why, it was asked, should not the Association hold its annual meeting, or at any rate a conference in London? The cases are not parallel, however. That there may be accommodation for what, by comparison, might be called sectional meetings, does not imply that a satisfactory plenary meeting could be secured in these days when few people are in a position to make promises as to attendance. On the other hand, the continued suspension of the meetings was most undesirable, especially in the interests of the committee work, one of the most essential factors in the activity of the Association. As a matter of fact, the preparations for the 1918 meeting had not been discontinued till this spring, and the Council had considered the alternative of a General Conference, the proposals of which had finally been withdrawn, however. So far as can be foreseen at present, after the deliberations of the General Committee on July 5, the Association will either meet at Bournemouth in 1919, or in default hold a General Conference in London in that year, and the invitation to Cardiff stands good for 1920. That the Association has not lost its hold on its old members and on scientists generally is proved by the fact that the response to the appeal for annual subscriptions—the majority of old members are life members—has been gratifying, and that some new members have joined in spite of the uncertainty of the position. The grants allowed for committee work were necessarily restricted this year; of the total of 268*l.* the Seismological Committee draws 100*l.*; Section G, Engineering, did not put in any claims for grants.

Though the 1917 meeting had to be cancelled, the committee work has not been suspended, and the British Association Report for the year 1917 was issued in June last, hardly later than usually; the report is not of the usual large compass, of course. The youngest of the committees, the Geodetic Committee, only created at the Newcastle meeting, has indeed been able to hold discussions in conjunction with the Royal Astronomical Society. This joint committee of Sections A (Mathematics and Physics) and E (Geography) has presented an interim report on a Geodetic Institute and the needs of Geodesy in its relations to other branches of Geophysics (chairman, Colonel Sir C. F. Close; secretary, Colonel E. H. Hills); another committee (chairman, Sir F. W. Dyson; secretary, Dr. S. Chapman) deals particularly with the promotion of geophysical studies in the British Empire. We begin our report with an account of the work of these committees on branches of science which so far have received far too little systematic attention in this country.

Geophysics and Geodesy.

The Geodetic Committee has reviewed the position of geophysical science in the Empire and considered proposals for a geodetic institute in the light of the needs of tidal phenomena, seismology and terrestrial magnetism as well as geodesy. There is, the report points out, no provision for the collection and critical discussion of the work which is being done within the Empire and for its comparison with what is being done in other countries. The various authorities, State and local, have no British institution to which they can refer for the latest data, for the methods which have been found effective in the Dominions and elsewhere under various conditions, for improvements in instruments, or for the latest advances in the theoretical field—except imperfectly in the case of terrestrial magnetism. There is no institution where those who have devoted themselves to geophysical science can improve their knowledge and carry out investigations. Passing to the different branches of geophysical science, the report states that a geodetic survey must form the basis and the control of all the State surveys of the Empire, on which about 1,000,000*l.* were spent annually before the war; geodetic triangulation and precise levelling are in progress in the United Kingdom, India, Egypt, Australia, New Zealand, Canada and South Africa, and are necessary in other parts of the Empire; determinations of gravity have been made in the United Kingdom, Egypt and at numerous coast stations, and they form part of the regular survey work of India, but are desirable elsewhere; and an institution for the systematic collection and discussion of the data and methods would be of great value to the State surveys. As regards tidal phenomena, three oceanic tide gauges are maintained in the United Kingdom, nine in India, four in Canada, two in New Zealand and one in Australia. There are nine seismological stations in the Empire, and a widely-spread network of stations is equipped with the simple Milne seismograph. The committee considers that one first-class seismological station would probably suffice for the United Kingdom; this station might form part of the Geodetic Institute as a centre to which the Colonies and Protectorates might refer for advice and assistance. As regards terrestrial magnetism the national provision is somewhat more adequate. Magnetographs are in operation, in Great Britain, at Greenwich, Kew, Eskdalemuir and Stonyhurst; at three places in India; one each in Burmah, Egypt and New Zealand; two in Australia (the one in West Australia is not yet established, however, and the other in Melbourne is to be moved), and two each in South Africa and Canada. At Greenwich Observatory (under the Admiralty) continuous magnetic observations have been taken and published since 1841; magnetic observations taken at sea under the direction of the Hydrographer of the Navy are used with others in preparing the Admiralty Magnetic Charts. The fund of 10,000*l.* which John Peter Gassiot conveyed in 1871 to the Royal Society is used for the support of these various geophysical studies.

The committee concludes that a geophysical institute is required; that it would be of great service to the State surveys and would have to co-operate with them; that the institute should be situated either near London or in London and should, in the latter case, have a suitable experimental station near London; and that the institute should be affiliated to an existing educational establishment. The Imperial College of Science and Technology was to be approached in this connection.

Tides and Tidal Currents.

The subject of "Tides and Tidal Currents" was discussed in a meeting, held on June 12 last, in the lecture hall of the Royal Astronomical Society, in connection with a preliminary report drawn up by Professor Horace Lamb, of Manchester, and Mr. J. Proudman, giving a survey of what is being done in the way of observation and reduction, but confined so far to the Empire and to the United States. The tide-tables, Professor Lamb considered, as at present produced appeared to be adequate for practical purposes, but in many cases the harmonic constants had not been determined with all accuracy obtainable; harmonic analyses, and indeed observations relating to oceanic island stations, seemed to be wanting, though they would be of great value; continuous observations of tidal heights at off-shore stations, and of currents, seemed especially desirable; greater accuracy seemed attainable in the harmonic analysis more particularly of the smaller diurnal and semidiurnal tides, the analyses being sometimes based on records covering periods of the insufficient length of one year, which were very uncertain owing to meteorological disturbances of the records. Accurate determinations of the constants for the long-period tides of astronomical origin were much wanted also, as they played a large part in various speculations as to the retardation of the revolution of the Earth about its axis, and as to the evolution of the planetary system. Finally, a knowledge of the free periods of oscillations of the ocean would be of great importance, also as a basis for dynamical reasoning on the actual forced tides.

Mr. Proudman, speaking after Professor Lamb, gave particulars of tidal analyses referring to Bombay, Port Blair (Andaman Islands) and Penobscot Bay (Maine, United States). Professor A. E. H. Love emphasised the importance of determining the actual tide heights out at sea and the position of nodal points, for the existence of which there was some evidence. Sir Joseph Larmor agreed with Professor Lamb that there was not much degradation of energy in oceanic tides, and the tidal motion was not an important element therefore in the retardation of the Earth's revolution. Captain Warburg, R.N., shocked the theorists by stating that harmonic methods could not predict all the tidal effects, and that he had obtained better results with respect to the very complex North Sea tides by an empirical method than by following the harmonic analysis which seemed to contain a periodic error. Major Taylor described a U-tube apparatus, to be lowered in a diving bell to the bottom of the sea, by means of which he hoped to watch the rise and fall of the tide there with the aid of flash photographs. He also gave the results of calculations he had made as the tidal dissipation of energy in the Irish Sea; Professor Lamb, in his reply, thought, however, that the figures arrived at, which would account for $\frac{1}{10}$ of the whole tidal effect, must be far too high.

Seismological Investigations.

The report of the Committee on Seismological Investigations, of which Professor H. H. Turner, of Oxford, is chairman, and Mr. J. J. Shaw, of West Bromwich, secretary, is the twenty-second report of a committee which was appointed at the Ipswich meeting of 1895 to take up the work of two committees, on Earthquakes and Volcanic Phenomena in Japan, and on Earth Tremors. The work had practically been done by the late Professor John Milne, who continued to devote all his energy to these investigations until his end. Improvements of his original simple, light-boom horizontal pendulum had occupied Milne, in conjunction with his assistant, Mr. J. H. Burgess—who remains in charge of Milne's station at Shide, Isle of Wight—and with Mr. Shaw, during the last year of his life, and the report points out, as in 1916, that the replacement of the Milne seismographs by either Milne-Shaw or Galitzin machines, is the present most important task of the committee. The Galitzin machines were elaborate, expensive and difficult to obtain at present. Mr. Shaw, likewise an original worker in this field, had also had difficulties in obtaining the materials for his simpler, inexpensive machines M.S.; yet he had been able to send two of his machines to America and to make other machines for abroad. The standardised M.S. machines could be relied upon to give similar seismograms, and it had been proved that their oscillation-periods could be adjusted even for long periods of 60 seconds, 90 seconds and 120 seconds; this last period of 120 seconds represented the high sensitivity of 1 mm. amplitude for a tilt of 1 in. in upwards of 8,000 miles. With the apparatus in this condition, however, the smallest movement of the observer affected the position of the light spot; when the observer was seated 6 ft. from the pier, on which the instrument rested, the swaying of his body produced an appreciable effect. Though the machine was mounted on a pier, measuring about 1 cub. yard, built from the floor of the cellar of Mr. Shaw's house in West Bromwich, the weight of a person two floors above, not immediately over the instrument, produced a tilt on the cellar floor of

0·07 second of arc, causing the light spot to be deflected more than 100 mm. When the rays of a small bijou gas mantle were reflected by a mirror so as to fall on one side of the column, the one-sided thermal expansion drove the light spot off the scale. A variation of the period with amplitude was also noticed. Of general interest is the observation that the air resistance of a long boom—the M.S. boom is short, and the magnification device comprises levers—forms the major part of the total friction.

As regards the already-mentioned agreement between standardised instruments Mr. Shaw erected two of his pendulums, adjusted to periods of 12 seconds and a sensitivity of tilt of 26 mm. = 1 second of arc, within 60 ft. of one another, the one in his cellar, the other in an outhouse. On quiet nights the microseisms of the two machines were identical, and they were really earth-tremors, not air-tremors, as had been suggested. But the daily wanderings of the zero were sometimes quite different, and this source of trouble, which was probably thermal, might account for peculiar discrepancies between the M.S. and Milne-Burgess instruments, to which attention had been drawn in former reports.

Professor Turner also mentions an improved method of photographic registration for Milne seismographs. At Edinburgh they had first used a crossed slit, but the diffraction pattern had made the trace indistinct. The following arrangement had then been adopted. The boom ended in a plate of blackened aluminium foil, in the centre of which was a hole, nearly 1 mm. in diameter ; over the hole was mounted a small achromatic lens, 9 mm. focal length, forming on the bromide paper an image of a small 4-candle lamp with coiled-up filament ; this lamp was fixed 30 cm. above the boom end, and a telescope ocular of 1 cm. focus was below it. The trace was a line less than 0·05 mm. thick which could be magnified 20 times.

The report further discusses the deduction of the earthquake origin from the seismograms and from the P and S waves (preliminary tremor and main waves) on them. The identification of the exact points where the waves set in is often difficult, especially for localities at distances of more than 90 deg. from the origin. Professor Turner's examination of the large earthquakes of 1913 concerns particularly the records obtained with Galitzin and Wiechert machines at different observatories, and he mentions that some errors in their former method of analysis had been pointed out by Dr. G. W. Walker, a member of the committee. Very striking is another point to which Dr. Walker draws attention in an appendix to the report, concerning the epicentre of an earthquake, the point in the interior of the earth from which the earthquake really originates. Assuming that the first impulse P on a seismogram corresponds to a longitudinal wave from the focus of an earthquake, the slope of the time curve for P as a function of the epicentral distance Δ is connected with the apparent angle of emergence ϵ by a formula into which V_0, the speed of the transversal surface waves, enters. Galitzin measured the ϵ directly at Pulkovo (near Petrograd) for Δ from 2,500 km. up to 13,000 km., and his results differ markedly from those deduced from seismograms with the aid of the Zöppritz tables. The connection existing between the minimum angle of emergence, which Galitzin found to be 42 deg. for Δ = 4,000 km., and focal depths had been established by Kövesligethy, and it would follow from Galitzin's observation that the focal depth was 1,300 km., i.e., about 10 times greater than the maximum estimate of the epicentral depth so far given. The result, Professor Walker remarked, was startling ; it agreed, however, with Wiechert's estimate of the depth of the discontinuity layer, and the whole question of the reflection of waves would have to be re-examined.

Terrestrial Magnetism.

The "Preliminary Report on Terrestrial Magnetism," drawn up by Dr. C. Chree, F.R.S., points out that any new scheme of work in terrestrial magnetism should take into account the existence of two agencies, the International Magnetic Committee and the Department of Terrestrial Magnetism of the Carnegie Institution at Washington. As in most countries terrestrial magnetism was regarded as a branch of meteorology, the Magnetic Committee came to be an offshoot of the International Meteorological Commission. When the International Magnetic Committee met last in 1910, at Berlin, under the presidency of General Rykatcheff (Russia), the British representatives were Sir Arthur Rücker (since deceased), Dr. A. Schuster, Dr. C. Chree. The committee's resolutions did not carry compulsion. The organisation of the international "quiet" days was now under the directorship of Professor van Everdingen (Netherlands). Every magnetic observatory sent in a quarterly list in which each day was characterised as quiet, moderately disturbed, or highly disturbed ; from these returns the director selected five quiet days for each month, and also some highly disturbed days, curves of which should be published. The quiet day, however, commenced at midnight Greenwich mean time, and the quiet-day diurnal inequalities thus referred to exact hours G.M.T. ; on the other hand, the International Committee recommended the use of local mean time for magnetic observations. Thus confusion arose ; the amplitude of the magnetic disturbances varied immensely at different stations, moreover, and the arbitrary attachment of a character figure was so unsatisfactory that a sub-committee, consisting of Everdingen, Schmidt and Chree, were considering another method suggested by Bidlingmaier, of Munich. With regard to the intercomparison of the absolute magnetic instruments the committee had proposed that each of the principal countries should, in succession, observe at foreign observatories in order to find out the differences between standard instruments ; one or two such sets of comparison had actually been made.

The second agency, the Department of Terrestrial Magnetism of the Carnegie Institution, was not international, its policy was largely that of its director (Dr. Bauer), and it had large funds at its disposal. Its work had been concentrated on magnetic observation at sea from the Carnegie, a ship practically free from iron ; this work should not be made an excuse for reducing official provision for necessary magnetic survey work, however. The Carnegie Institution standards were not international standards moreover, and care should be taken lest magneticians found themselves in the position of the electricians of twenty and more years ago with respect to resistance standards. At one time magnetographs of the Kew pattern were in a majority, and absolute instruments (magnetometers and dip-circles) were largely made in England and verified at Kew, which observers from foreign countries visited for instruction. But circumstances had altered. Large magnets had gone out of fashion, partly because the defects of more recent patterns had had less time to become generally recognised, and the smaller, inexpensive Eschenhagen magnetography had been adopted at many recent observatories. These instruments also obtained a higher sensitiveness than the Kew pattern by the aid of two mirrors on the H magnet, slightly inclined to one another and by the use of a wider photographic sheet without increasing the risk of loss of trace. The higher sensitiveness might, however, become a disadvantage, especially at naturally disturbed stations in high latitude and at others in temperate latitudes exposed to artificial sources of disturbance. Dr. Chree further discussed the question how averages should be taken when traces were wholly or partly lost, owing to accidents to the instruments —ordinary stations had only one set of magnetographs, as a rule—or because the trace went off the sheet, and finally expressed the opinion that a magnetic observatory in high latitude was most desirable, further north than Eskdalemuir in Scotland, or better still in Canada.

(To be continued.)

British Chamber of Commerce, Paris (Incorporated).—This Chamber of Commerce, whose address is 6, Rue Halevy, Paris, 9, recommends those of its subscribers having business interests in France, and all British firms wishing to open up trade in that country, to communicate with the secretary, at above address. The chamber has given in the past, and is in a position to give now and in the future invaluable aid to British commerce and industry, in connection with trade between this country and France.

NOTES.

A Professorship in Aviation.

It is gratifying to record that a professorship of aviation is to be instituted at the Imperial College of Science and Technology, which is associated with the University of London. The enormous progress made in aviation during the war has proved the potentialities of this method of transport, especially for mails and precious goods in peace time, and the professorship will be a means of co-ordinating thought on the scientific and theoretical problems which are essential to the direction of inventive ingenuity along correct lines. The institution of the professorship has been made possible by the placing at the disposal of the Government of 25,000*l.* by Sir Basil Zaharoff, G.B.E., who in past years has done, in a most unostentatious and almost secret way, much for the benefit of this country, as well as of our friends amongst the European nations. His munificence has been particularly marked since the outbreak of war, although this is the first occasion on which any official announcement has been made of his services and benefactions. He has made a similar gift to the French and Russian Governments, and chairs of aviation are also to be founded respectively at the Universities of Paris and Petrograd, in order to assist the progress of aviation amongst the Allies. In all cases the professorship will be called the "Zaharoff Professorship of Aviation," and the donor has expressed the hope that the occupants of the chairs will continuously exchange views on the work done by them.

Electric Resistivity of Carbon in Hydrogen Atmospheres.

Measurements of the resistance of carbon filaments when heated in a vacuum and in gases having given unexpected results, especially when the gas was hydrogen, Mr. T. Peczalski, of the Nela Research Laboratory, of the Lamp Works of the General Electric Company in Cleveland, Ohio, conducted some experiments, which are described in the *Physical Review* of May, 1918. He mounted special filaments of coke-carbon, 1·6 mm. in diam., 10 cm. long, in a small chamber capable of bearing considerable gas pressures. He measured the resistance of the filament in the highly evacuated chamber, heated the filament up to about 2,000 deg. C. absolute, cooled it, re-determined the resistance, then admitted hydrogen, raised the pressure up to 33 atmospheres, heated for periods of from 10 seconds to 50 seconds, cooled and re-determined the resistance always, it will be understood, while the cold filament was at room temperature. Most of the filaments rapidly disintegrated under this treatment. Other similar tests were then made with ordinary lamp filaments in their bulbs, but the heating was not pushed beyond 1,590 deg. C. absolute ; the temperatures were estimated from the brightness of the glow ; only two of six filaments survived these tests. It was observed that the resistance of the filament was not changed materially by the presence of hydrogen at high pressure ; a new filament lost 35 per cent. of its resistance by being heated *in vacuo* (molecular air pump) ; when the heating took place in hydrogen, the resistance increased with time, but only by about 0·1 or 0·2 ohm (from 1·7 ohm) to go down again in about a minute, by about the same amount when heated *in vacuo*. In the further experiments made with carbon filaments in large bulks, the resistances of the hot carbons were determined, not after cooling as before, but at temperatures of 300 deg. C. and 1,590 deg. C. absolute. The heating in hydrogen increased the resistance progressively by 3·5 per cent, and altogether by 6·5 per cent., reckoning from the cold resistance ; the effect was greater for the higher than for the lower gas pressures. To account for the phenomena it is suggested that the absorption of hydrogen by the carbon of the filament is not merely of a mechanical nature, filling up the pores. The gas mechanically absorbed is given off again at comparatively low temperatures (about 300 deg. C.). When carbon is heated in hydrogen, at high temperature, however, the gas and carbon form a solid solution or some hydrocarbon, the solution or compound being fairly stable as long as the pressure at that temperature does not sink below

3 atmospheres. At the high rarefaction produced by the molecular pump, in particular, a loss of hydrogen takes place. Peczalski points out that secondary effects, such as the sublimation of the carbon and its allotropic transformations, would affect the results; but even apart from these effects, the experiments are not conclusive.

Electrolytic Zinc.

When writing on the British spelter industry recently, we expressed the opinion that electrolytic zinc methods would ultimately gain a footing. Holding similar views, in spite of all prejudices against industrial zinc cells and of commercial failures of electrolytic zinc plants, Mr. C. A. Hansen, of the General Electric Company's Research Laboratories, has, for years, been experimenting on a large scale on the electrolysis of industrial zinc sulphate solutions. The account which he gives of his investigations in the Bulletin of the American Institute of Mining Engineers, March, 1918, may be considered discouraging rather than encouraging. For he insists that the electrolyte should be pure, though he does not state how that purity can be secured; that would be another problem. He discusses the influences of impurities and of the conditions of the electrolysis. His ores and concentrates were obtained from three American sources, one of the materials being Californian flue dust, and from four Tasmanian and Australian sources. The ores contained practically all the impurities one might expect, the Californian dust being the most impure (with 7·35 per cent. of arsenic). Unfortunately, Hansen does not give analyses of his electrolytes, and one misses other figures in his account. The cells were of 20, 200, or 1,000 amperes capacity, the electrodes ($\frac{3}{8}$ in. kathodes, $\frac{1}{16}$-in. anodes of lead peroxide) were spaced 2 in. apart and fully immersed in the electrolyte, which generally contained 100 gm. of zinc per litre to start with, and the electrolysis was carried on, for 48 hours in some cases, until the zinc deposit per sq. ft. of kathode surface was 7.4 lb. in some instances; 3 lb. to 5 lb. would be industrial practice. The concentration, acidity, current density, temperature, &c., were varied in very wide limits to ascertain their influences on the current efficiency, the character of the deposit, &c. During the electrolysis deposition of zinc goes together with corrosion and redissolution of the zinc, owing to chemical attack, local couples, &c., and these features largely depend on temperature, acid concentration, purity, &c. The proportions of the primary electrolyses and of the secondary corrosion are difficult to decide. High current densities gave rough deposits, especially at low acidity; but the acidity naturally increases as the electrolysis proceeds, and Hansen does not appear to have made experiments in which the acidity was kept constant. As regards the impurities, he distinguishes between (*a*) non-cumulative impurities, which ought to have been removed by the previous purification of the electrolyte, and (*b*) cumulative, which concentrate in the electrolyte. The (*a*) group comprises copper and cadmium, which fall out with the zinc, and form local couples (especially copper) and hence corrosion; arsenic and antimony, which are only partly deposited together with the zinc, and have a bad effect, especially in the presence of manganese, when even traces of antimony may ruin a cell; manganese, which in itself does little harm, as it is precipitated as insoluble MnO_2; and iron, which is easily oxidised and reduced again, and hence detrimental. Of the cumulative impurities, magnesium and the alkalis are fairly harmless, whilst cobalt, nickel and vanadium are decidedly detrimental, even in traces. Impure solutions always yield defective deposits, though the deposition may apparently proceed satisfactorily for hours, and then turn into corrosion for no obvious reason. Low current efficiency means, of course, that the current does undesired work, one of these effects being that the electrolyte is heated and becomes more corrosive, and that complex chemical reactions are accelerated. When a cell becomes too impure, it should be emptied; the current intensity may also be lowered to keep the heating down; finally, certain organic reagents, glue, lanolin, &c., may be added to the electrolyte. This third remedy temporarily improves the deposit, but has no lasting good effect, Hansen states; he differs in this statement from some other experimenters, but he is probably right in this, and in accentuating the importance of pure electrolytes. The permanganates, which are valuable purifying reagents, are, unfortunately, very scarce at present.

LITERATURE.

The Composition of Technical Papers. 1917. By Homer Andrew Watt, Assistant Professor of English, New York University. New York: McGraw-Hill Book Company, Inc.; London: Hill Publishing Company, Limited. [Price 6s. 3d. net.]

An oft-quoted phrase of Boileau runs to the effect that what is clearly conceived can be easily expressed, but apparently the author of this work cannot support that direct proposition. He regards the engineer as peculiarly incapable of giving utterance in terse and vigorous language to what concerns his professional duties. Yet it must be admitted that the engineer enjoys ample opportunity of forming distinct notions of the technique of his work, and therefore should find no difficulty in conveying his information to others. The man who designs a piece of apparatus, or has watched every detail in the construction of engineering plant must have acquired very well defined conceptions of its purpose, and of the means by which that purpose is attained. Of all men he should be the most competent to develop the logical steps that suggest a successful result, or to explain the method by which the end has been achieved. Nevertheless, we believe that Professor Watt is correct in his view, and that training in forms of expository writing is desirable, not necessarily from any deficiency on the part of the engineer, but in order to overcome the deficiencies of an untrained and unscientific public. What his familiarity with engineering construction has not taught the engineer is the provision of an effective channel for reaching an audience. This defect the author seeks to remove, and he is right, for certain conventionalities may not be disregarded, since some consider the manner in which a statement is made of more importance than the matter it contains.

If it be asked whether it is desirable to give instruction purposely designed to assist an engineer to write successfully the technical papers connected with his vocation, a quite different set of problems arises. We are then concerned with fundamental education. We have to consider, in the interests of the student himself, whether literary education should not be schemed on such liberal lines, that he will be able to express himself in grammatical English with precision, lucidity and attractiveness. To obtain the necessary mastery over English implies no insuperable difficulty, although it is frequently and loudly asserted that such attainment is reserved to those only who have acquired a thorough knowledge of Latin and Greek. There is little evidence to support this statement. The English of the classical scholar is as a rule not superior to that of his colleague trained in the science schools. The insistence on this fallacy is not only misleading, but may be positively mischievous, making the science student distrustful of himself and inclined to attribute his shortcomings to the wrong source. If, further, he be persuaded that the art of writing is one difficult of attainment, requiring long preparation, and that only one avenue is open for its acquisition, he will be still more discouraged and disinclined to make the necessary exertion to overcome the initial difficulties.

But because a classical education has been denied, no one need have been deprived of the very moderate amount of training covered by the first part of this treatise. To be reminded at a late period of one's education of the elementary principles here set forth and illustrated is to suggest that the general education has failed, or has been painfully lobsided. The principles discussed in these preliminary chapters have no special reference to engineering topics or to technical work; they include the rules that govern composition generally, and apply equally to all who desire that their conceptions should be transmitted with accuracy and received with attention. The necessity for unity, coherence, and proportion, is set forth with vigour and illustrated with cogency. Many suggestions are pertinent, and an evident effort is made at times to represent a piece of practical advice as peculiarly applicable to forms of technical writing. For instance, we are told that the introduction "of unnecessary or irrelevant matter detracts from the value of a technical paper." Perfectly true, but is such a defect more glaring, more injurious, in a technical paper than in any other? The dragging in of the word technical here seems to imply that the engineer is especially liable to indulge in the vice of "long and burdensome preludes." However, if the advice concerning introduction appears jejune and misdirected, we have nothing but praise for the counsel offered concerning the difficulties that surround a telling conclusion. The caution is expressed with a terseness that is as commendable as the advice is sound. "When through, stop." "The writer," says Professor Watt, "who is convinced that he should introduce his paper with a flourish of trumpets, is also certain that he should bow his subject formally off the stage." This is a temptation that lies in wait for the unwary, who in his desire to be impressive succeeds only in repeating himself and wearying his readers. This treacherous pitfall, however, invites the lecturer more insidiously than the writer. "Most men say too much; few men say too little," is more good advice to be treasured by the unpractised writer or speaker, whatever be his profession.

In the second part of the book the author approaches his subject more closely, by attempting to explain and illustrate the specific principles that mould those forms of composition that more particularly fall within engineering experience. For convenience the plan of instruction is treated in three sections, entitled "technical description," the "exposition of processes," and the "exposition of ideas," but the distinction between these divisions cannot be strictly maintained. Pure description, or argument and deduction, may and do enter into the compositions included in either of these sections, but it is thought that the writer's aim and purpose may disclose such differences as to warrant separate treatment or make analysis and discussion more profitable. The plan of instruction or guidance pursued in all three sections is to exhibit specimens of composition and to leave the dissection of these generally to the pupil or the teacher. One class of these specimens is written by students, and illustrates imperfections on the one hand with fitness or merit on the other. Another class includes extracts from the work of master hands more suitable for models, but all these are not considered "perfect in the larger matters of whole composition and paragraph, and many of the sentences are far from impeccable."

Imitation and practice lie at the root of the method; apparently there is no room for original treatment, for the American professor seems amply satisfied with the result of the system. The aim is to teach how a satisfactory and efficient scaffolding may be erected to support the structure that it is intended to carry; but original building is hardly contemplated or encouraged. The author is satisfied so to train his pupils that they should be incapable of violating the rules that have been generally approved, and also to be observant of the principles that have been practised by writers of repute. This is a modest ambition, but it is doubtful whether instruction, especially class instruction, can go any further. For the next step we must look to genius and this is not communicable by rule.

BOOKS RECEIVED.

The Year-Book of Wireless Telegraphy and Telephony, 1918. London: The Wireless Press, Limited, Marconi House, Strand, W.C. 2.

Aircraft Mechanics Handbook. A Collection of Facts and Suggestions from Factory and Flying Field to Assist in Caring for Modern Aircraft. By Fred. H. Colvin, A.S.M.E. London: Hill Publishing Company Limited. [Price 3 dols.]

The Principles, Operation and Products of the Blast Furnace. By J. E. Johnson, Junr. London: Hill Publishing Company, Limited. [Price 25s. net.]

Willing's Press Guide and Advertisers' Directory and Handbook. 1918. Forty-fifth year. A concise and comprehensive index to the Press of the United Kingdom. A list of telegraphic and reporting agencies. Lists of the principal Colonial and foreign journals, and a variety of general information. London: James Willing, 125, Strand, W.C. 2. [Price 1s.]

THE ATTEMPTED SALVAGE OF THE BATTLESHIP "IMPERATRITZA MARIA."

THE first Russian Black Sea Dreadnought Imperatritza Maria, was lost on October 21, 1916. The particulars of her design were: displacement, 22,500 tons speed, 21 knots. Her turbines, built by Messrs. John Brown & Co., Ltd., of Clydebank, were capable of developing about 30,000 h.p. on four shafts. Her armament was twelve 12-in. guns, 52 cal. long, mounted in four turrets placed on the centre-line of the ship, the arrangement being similar to that of the Austrian Dreadnoughts of the Viribus Unitis type. Her auxiliary armament consisted of twenty 130 mm. quick-firing guns, 55 cal. long, placed in casemates along the side, six on each side in the forward half of the ship, and four on each side in the aft half of the ship. The ship herself was built by the Russian Shipbuilding Company under the supervision of Messrs. John Brown and Co., Limited, and was the first of three similar ships ordered by the Russian Government for the Black Sea Fleet in 1911.

The circumstances of her disaster are, in brief, as follow:—Early in the morning, October 21, 1916, shortly after réveillé had been sounded, fire in the magazine of the forward turret was reported, and immediately an explosion followed, which destroyed the foremast, the fore conning-tower, and the fore funnel. By this explosion, the forward boiler-room, the only boiler-room in which the fires were being kept at that time, and the forward dynamo, which was working, were also destroyed, and in consequence the ship was left without steam and light. The main explosion was followed by several smaller explosions and the foremost third part of the ship from the bulkhead No. 55 forward (the total number of frames was about 135), was practically isolated. Nearly every member of the crew who was at that time in the washing rooms or around the turret No. 1, was killed. The absence of light and steam made the conditions very difficult, but, nevertheless, the fire was extinguished by flooding the burning compartments, opening the suitable Kingston valves, and putting in operation the fire pumps. After the steam had been raised in boiler-room, No. 5 (frames, 74½–80), the danger of fire seemed to be over, and the officer in charge of the fire system gave orders to begin to correct the trim of the ship, which had her bows almost under water. Suddenly the vessel took a very heavy list and then turned turtle in about 1¾ minutes, approximately, 1 hour 45 minutes after the first heavy explosion. About 200 men lost their lives in this disaster, the true cause of which is still uncertain. It could not be due to the spontaneous ignition of the powder, as the Russian propellant is very safe in this respect. The ship had had her magazines filled the day before, as an expedition against the Bulgarian coast had been planned. It is suggested that the disaster had been organised by some enemy agent.

The position of the ship after she had finally sunk was as follows:—She had about 30 ft. of water over her forward end, and only about 8 ft. over stern, with a slight list about 8 deg. to port. The hull sunk in the mud up to the second deck. The shell plating was not damaged by the explosion, as far as the divers could ascertain, and no damage was done farther aft than the frame, No. 55. The best scheme of salvage was that suggested by General A. Kryloff. This was to fill the ship with air, forcing out the water, to cause the vessel to re-float upside-down. Then the holes and openings were to be made water-tight, and the ship was to turn turtle again, similar to the method used by the Norwegian shipbuilders in launching reinforced concrete ships, built upside-down.

The decision to lift the ship was made immediately after the disaster had happened, but the discussion of methods of salvage and negotiations with various companies, who offered their service for this work, and political events prevented the actual commencement of the enterprise until the summer of 1917. It was then finally decided that the salvage should be attempted by the Sebastopol Dockyard, and the task was entrusted to naval architect, Colonel Sidersner.

The scheme finally approved was as follows:—Access to the inside of the ship was to be obtained by cutting manholes through the double bottom, one for each turret, the total number being four. To each manhole a shaft with air lock was to be fitted, of the type used for working with compressed air on bridge foundations. The water was then to be forced out of the magazines by gradually increasing the air pressure, until the shells and the cartridges could be removed.

There was no difficulty in finding the necessary appliances, and the staff of men experienced in working under compressed air, as just at that time the construction of some new bridges in the South of Russia was finished, and the contractors agreed to sell their plant, and release their staff for this job. Admission into the magazines of turret No. 4, the after one, was made very easily, as the bottom of the ship was only a few feet under the water. An open caisson was fixed on the place chosen, the water pumped out, and the manhole was cut through the ship's bottom. A special collar was fitted to suit the shape of the bottom and receive the shaft and air-lock. At the end of September, 1917, the first men entered the ship, and arranged the electric light fittings to facilitate the work. The writer of the present article, who had been in charge of erecting the machinery and appliances on board of the ship, was invited to visit the scene and to explain the various piping systems and the general arrangement of machinery.

At that time the working pressure of the air was about 20 lb. per square inch, and the water-level inside the ship was about 16 ft. below the bottom—as the ship was upside-down. In the magazines everything had been broken by the impact of the heavy shells, about half a ton each. As the ship turned over, cases of powder, shells and debris of the broken gear for transferring the shells and powder to the turrets, were all mixed in terrible confusion. Some of the shells had their fuses fitted, and great care was necessary in handling them to avoid a repetition of the disaster. The turret itself fell out of its seat, and sank in the mud about 14 ft. Its bearing could be seen a few inches above the water-level inside of the ship.

From the magazine a manhole was cut through the bulkhead into the port condenser room, where the water-level was, approximately, the same as in the magazines. But the condition of the room was quite different from that of the magazines. Every pump, the condensers, main and auxiliary, and everything else remained intact, except the floor plates, which having been laid unfastened, fell down or upwards, referring to the normal position of the ship, and in so doing, smashed a few electric lamps and the scale of the torsion-meter. In spite of one year's immersion in sea water, the metal was not seriously corroded. A thin layer of a sticky mud enveloped the machines and bulkheads, causing an insignificant corrosion to unprotected parts. It was a peculiar sensation to be in the room with everything in its place, but everything upside-down. As already mentioned, the general plan was to obtain an entrance into all the magazines, and after having taken out the shells, to refloat the ship, and subsequently to dock her for necessary repairs and work preliminary to turning turtle again to the normal position. But as the watertight bulkheads were not quite watertight, and by no means airtight, there was a danger lest the water should be forced out of the whole of the ship, and not from the certain compartments only. That circumstance, combined with the considerable diminution of the weight, owing to the turrets having fallen out, thus removing 3,200 tons, made the ship refloat quite unexpectedly. She lifted in the first half of November, instead of about Christmas, as had been calculated. The actual lifting occurred during the night, when only a few men were on board. They became aware of the fact when the danger of a disaster was over entirely.

The general unrest in Russia and the massacre of officers at Sebastopol, have caused this very interesting enterprise to be suspended for an indefinite time, and there is no news about the salvage being renewed.

To dock the ship upside-down, it would be necessary to cut off the aft funnel, the aft mast and, what would be more difficult, to cut off the aft-conning tower. With those parts protruding below the deck, it would be impossible to dock the ship. Otherwise the operation of docking would be simple, and would only require special arrangements of keel-blocks, which in this case should be rather named deck-blocks. In connection with the condition of the shell plating, it might be necessary to remove a part, or even the whole, of the armour belt before the ship was righted, but this question can only be solved after a careful inspection of the vessel in dock. On the results of this inspection will depend the future fate of the ship. But one part of the task—the clearing of the harbour—would undoubtedly be accomplished at comparatively small expense.

EXPORTS OF MACHINERY FROM CANADA.—The Board of Trade have received from H.M. Trade Commissioner at Montreal copy of Customs Memorandum No. 2201B, dated May 23, 1918, cancelling Customs Memorandum No. 2198B of May 17, 1918, and specifying the conditions under which machinery may now be exported from the Dominion. The present memorandum states that: (1) The Order-in-Council of March 9, 1918, prohibits the exportation of machinery (all kinds) to all destinations outside of Canada, except under licence issued at the request of the War Trade Board. (2) The classification of various classes of machinery in Memorandum 2172B, which specifies the list of prohibited exports, being based on previous Orders-in-Council, is therefore changed, and all kinds of machinery now fall under Class E, as defined in Memorandum 2172B (i.e., exportation prohibited to all destinations). (3) It is now required that applications be made to the War Trade Board, Ottawa, for approval of individual licences for the export of machinery, of metal, of every kind, to all destinations outside of Canada.

INDUSTRIAL NOTES.

The Secretary of the Ministry of National Service makes the following announcement:—

Some misunderstanding having arisen with regard to the terms under which men of the new military age may be enrolled as War Work Volunteers, the Ministry of National Service desire it to be known that: (1) Men who are graded 1 and were 45 on January 1, 1918, cannot be enrolled. (2) Men who have received calling-up notices after July 6 cannot be enrolled after the receipt of such notices. (3) Men can only be enrolled under the "Z" class if they are physically fit to undertake and are accepted for work of a very heavy labouring nature. (4) War Work Volunteers can only be enrolled if placed by the Employment Exchange in vacancies previously sanctioned by the Ministry of National Service.

A strike of woodworkers in the aircraft industry in London originated at Messrs. Waring and Gillow's, Alliance Aeroplane Works, on Wednesday, June 26. As to the origin the Minister of Munitions issued the following statement:—

The strike followed upon the dismissal of a shop steward named Rock on June 26. The reason for his dismissal was that he had blown a whistle summoning a meeting of workmen during shop hours although a previous warning had been given that meetings of this kind must not be summoned during shop hours. In any case it is obvious that the calling of meetings in this way must necessarily gravely interfere with production and discipline in the shop. The Ministry of Munitions was thereupon brought in touch with the duly constituted trade union leaders of the aircraft industry in London with a view to arriving at a settlement. It was agreed on Wednesday, July 3, with the unions that work should be resumed at the Alliance Aeroplane Works on Thursday morning, and that arbitration should follow at 11 o'clock on that morning, on the clear understanding that one of the questions which would be submitted to arbitration would be whether or not Rock should be reinstated. The Minister observed his part of the arrangement, and on Thursday morning, at the time specified, an independent arbitrator appointed by the Ministry of Labour attended at the works. He found, however, on arrival that the men had not resumed, and it was then discovered that the unofficial representatives of the men had, contrary to the advice of their legitimate trade union representatives, advised the men not to resume work. The result of the men's refusal, on the advice of their unofficial representatives, to resume work on Thursday morning was a considerable extension of the trouble throughout the London area. In spite of the fact that time has been given to the men to think better of the matter work has not been resumed.

The Minister, therefore, wishes it to be known: (1) That the strike is not only illegal but is unauthorised by the trade unions; (2) that arbitration was accepted by the trade union leaders and has been brought to nought by certain persons not representative of any recognised labour organisation; and (3) that the interruption of work is a serious interference with the output of munitions.

The following, issued officially on the 10th inst., is a summary of the announcement made by the Minister of Munitions to the workmen's representatives whom he met in conference at the Ministry of Munitions on that day on the subject of the aircraft strike:—

The Minister of Munitions has during the last two days conferred personally with all the parties concerned in the dispute at the Alliance Aeroplane Works. He has come to the conclusion that neither side is wholly free from blame. The strikers have committed an illegality in leaving their work. They have also thrown over their regularly constituted trade union leaders. On the other hand, the Minister cannot feel that the management has been instructed or sympathetic. Neither side have shown themselves in the course of the dispute sufficiently alive to the grave responsibilities imposed upon workmen and employers alike by the present situation of the war. Both sides have, indeed, intimated their willingness to accept arbitration and to be bound by its results; but it is impossible to arbitrate on a matter that is at the moment the subject of a strike. The workmen, however, declined to resume work unless Mr. Rock (the chairman of the Shop Committee) is reinstated pending the results of the arbitration. Mr. Rock himself, and the trade union authorities concerned, tendered to the Minister an undertaking that, if he were reinstated temporarily, he and his comrades would strictly conform to all the rules of the establishment during the process of arbitration and would be loyally bound by its findings. The firm, however, were unable to entertain this proposal. The deadlock was complete and the area of the dispute was continually being widened throughout the country. It is believed by the workmen generally that the firm

in question has opposed the legitimate development of the Shop Steward and Shop Committee movement. The Minister, without pronouncing a final opinion, has formed the view that this belief is not wholly unfounded. Certainly it would have been preferable, having regard to the representative position of Mr. Rock, to have proceeded against him by a prosecution under the Munitions of War Acts rather than by summary dismissal. It would be intolerable that at a moment like this an industry so vital to the safety of the country should be thrown into confusion by a conflict of this kind. The Minister, therefore, has felt it his duty to invoke his legal powers as far as they may be necessary, under the Defence of the Realm Act and the Munitions of War Acts. In consequence he has directed that the establishment in question be taken over forthwith by the Government. It may take a few days for the Minister to assume effective control. Priority of employment in this factory under the new control will be accorded to all previously engaged there, provided they immediately apply for such employment. An inquiry will be held into the circumstances of the discharge of Mr. Rock from his late firm, and should such inquiry show him to be to blame his dismissal will follow. Meanwhile the strikers at this establishment are reminded that as soon as the firm against whom they have struck have been taken over by the Government, they are no longer strikers but merely unemployed or idle workmen. It is accordingly the duty of these men and all others on strike in sympathy to resume work immediately. Failing such resumption, the Minister will use his powers against them under the Defence of the Realm Act and the Munitions of War Acts.

A settlement was arrived at on this basis, and was accepted by the men's representatives in the following terms:—

"That we, the National Woodworkers' Aircraft Committee, London District Aircraft Committee, and other representatives of the workers (both metal and wood) hereby pledge the whole of the men and women now on dispute to loyally abide by the decision of the proposed inquiry if Mr. Rock be allowed to start work as soon as the Ministry of Munitions has assumed the effective control of the factory and that if Rock be acquitted, he shall receive compensation from the date of his dismissal from the Alliance Aeroplane Company. Further, we hereby recommend an immediate resumption of work at all shops now on dispute."

Speaking at the annual general meeting of the General Electric Company, Limited, held in London on Monday last, Mr. H. Hirst, the chairman and managing director, said that the gratifying results the company had obtained were not in the main due to any special work outside the company's own industry; with very few exceptions they manufactured in all their shops the same products that went through in pre-war times, with the addition of those which necessity, invention or experience had created during the war. These latter would form a basis for much fruitful development after the war. Their Witton works produced every kind of dynamo and motor for power or lighting, from a 20,000-h.p. turbo-generator down to the smallest electric fan. If electrical concerns, added Mr. Hirst, were to open the door for British enterprise abroad they must in future be enabled to carry out complete contracts. It was little realised that average electrical contracts brought as a rule only 10 per cent. or 15 per cent. of work into purely electrical shops. The work connected with it automatically brought 85 per cent. or 90 per cent. of work into engineering and other industries. Firms that had carried out the lighting and power installations of Berlin or Chicago had a better opportunity of securing foreign contracts than British firms, which, although their complete range of products might be equally good or better, could only show that they had carried out a section of an installation at Manchester, Glasgow, or Birmingham. In accordance with this policy the company had acquired the ordinary shares in Messrs. Chamberlain and Hookham, Limited, one of the most prominent electricity meter manufacturers in the country. This was also the reason why the General Electric Company had acquired the works of Messrs. Fraser and Chalmers, Limited, at Erith. That firm had gained a splendid engineering reputation, and without a doubt would have greater chances of development in conjunction with an electrical firm such as the General Electric Company.

Sir John Randles has more than once stated, says *The Manchester Guardian*, that the future of the steel industry will be with those who can do things on a big scale, and he puts that view into practice. He was chairman of the Workington Iron and Steel Company, which started in 1909 as an amalgamation of four Cumberland properties. In 1915 the Harrington Coke Ovens Company was added and in 1917 the Bigrigg Mining Company. The coal-mining industry was also developed. Last March an amalgamation with Steel, Peech and Tozer, Limited, Samuel Fox and Co., Limited, and the Rother Vale Collieries, Limited, was arranged, and as part of that transaction the Frodingham Iron and Steel Company and the Appleby Iron Company were swept into the net.

Now, the Workington correspondent of the *Guardian* telegraphs, there is to be a further expansion, the combination—known as the United Steel Companies—having made a provisional agreement to acquire the Distington Hematite Iron Company's ironworks at Distington and the Beckermet Mining Company's high-grade iron ore mine at Beckermet. Both places are in West Cumberland, and the properties it is proposed to acquire can doubtless be worked economically in conjunction with those already held in the Workington district. The Beckermet Mining Company owns or owned, both iron and coal mines, and has a paid-up capital of 114,961*l.* Its accounts are not published, but according to a balance-sheet, filed at Somerset House it had a credit balance of 15,786*l.* in October, 1916, before providing for the excess profits duty. Sir John Randles is one of its directors. The Distington Hematite Iron Company has in issue preferred shares for 21,200*l.* and ordinary shares for 22,800*l.*, besides debentures. The correspondent states that it has two furnaces in blast on special iron at Distington. For 1915–16 it paid 10 per cent. on both classes of shares, and for 1916–17, 6 per cent. free of tax. It is said that the purchase price in both cases will be 2*l.* for each 1*l.* share.

The average net selling price of No. 3 Cleveland pig-iron for the three months ended June 30 last has been certified at 107*s.* 10·68*d.* per ton, as compared with 108*s.* 3·59*d.* per ton for the first quarter of the year. This means a reduction in blast-furnacemen's wages from 95·25 per cent. above the standard to 94·75 per cent. above the standard. The reduction has taken effect since the 7th inst.

Mr. Paul E. Derrick, 34, Norfolk-street, Strand, W.C. 2, has issued, free of cost, an interesting pamphlet in which he deals exhaustively with the question of trade marks in all its various phases. The space at our disposal does not allow us of reviewing it in detail, and we shall limit our references to the quoting of several paragraphs: ". . . There is undoubtedly a great desire on the part of the Allies to unite upon some policy to protect their domestic trade and to benefit their post-war international commerce. Any such effect is certain to be welcomed by trade mark owners, but any move in this direction should be closely supervised by those who are familiar with trading conditions throughout the world, and not be left to a clamorous, uninformed public, to vociferous politicians, or to armchair economists. . . . An official of an American Department of Commerce has instanced the case of the typical manufacturer who neglects to register his trade mark in a foreign country to which his goods are shipped by export merchants. It frequently happens that some merchant selling these goods abroad registers, in his own name, the mark of the manufacturer. This is permitted in some countries, notably in South America, where the practice is rampant at the present time, and presumed to be of German origin. . . . It is important that the drafting of commercial laws by politicians and uninformed officials in Star Chamber Session must be extinguished and replaced by a national policy and practice for sounding expert commercial opinion upon all points affecting national commerce. This can be adequately accomplished only through the efficient organisation of producers, to provide the Government with the authoritative sources of information concerning these matters. . . ."

We recommend the pamphlet to all engaged in British trade.

The Bristol Association for Industrial Reconstruction has issued, at the price of 3*d.*, post free 3½*d.*, its report of a conference on Works' Committees, between Bristol employers and trade unionists, held in April last. Among other points dealt with, the report says it was strongly felt that every worker, where the loss of his job is concerned, should have the right of appeal to some such tribunal as a Works Committee. It was agreed that the system which confers upon foremen the right of dismissal is obsolete. Responsibility for dismissal must in practice remain with the management, but in all cases of dismissal, for reasons personal to the worker, he or she should have the right of appeal from the decision of the management to the Works Committee. With regard to the termination of the contract of service upon grounds other than those personal to the worker, such as the end of a job or reduction of staff for any reason, it was felt that an advantage to all concerned would often be secured if the circumstances were discussed with the Works Committee beforehand, and an explanation afforded them as to why it was necessary to reduce the staff. This would give the workers an opportunity of advising as to the most suitable men to go, or to assist the management, possibly, by devising means of reorganising the work so as to avoid the necessity of men being paid off.

After the war, states the report, demobilisation, rationing of materials, and other difficult and subtle matters will call for settlement, and in the view of the association an understanding can only be reached in an atmosphere of confidence and goodwill; their experience leads them to the conclusion that it is from the individual works alone that this atmosphere can radiate.

The same association has issued, at the price of 6*d.*, post free 7*d.*, a report on "The Position of Women in Industry after the War," being the result of a conference held in March last, between organisers of trade unions, Bristol employers and others concerned with the industrial employment of women. It states that at the present time it is estimated that not less than 4,713,000 women are engaged in industrial occupations, covering well-nigh the whole field of industry. At the end of the war a very large number of these women will be displaced as war industries are shut down and factories gradually pass from a war to a peace footing. The absorption of scores of thousands of women thus displaced from occupations which they have followed for a prolonged period will create a series of industrial problems of an exceedingly grave character. The association are of opinion that the number of women desiring to remain in industry after the war will very greatly exceed the number of women engaged in industrial occupations before the outbreak of hostilities.

According to the association, the underlying fact in relation to the employment of a woman in industry is that her position as an industrial worker is and always must be of secondary importance to her position in the home. To provide the conditions which render a strong and healthy family life possible to all is the first interest of the State. It is accordingly the duty of the State to ensure that women are only employed as factors in industrial efficiency in so far as the interests of family life and the healthy development of the race are not prejudiced. Whilst the experience of the war has shown that women can adapt themselves to the needs of almost any calling, it is clear that many occupations now being followed by women are unsuitable for the permanent employment of female labour. The report then reviews the numbers of women employed in various occupations in July, 1914, and in October, 1917, and states: (1) That the first consideration should be to arrange for the suitable employment of all demobilised men, and men discharged from industrial establishments engaged upon the production of munitions of war. (2) That women should, as a matter of course, relinquish the jobs in which they have replaced men for reasons directly or indirectly attributable to the war, so long as men are available to fill them. (3) That the school leaving age should be raised to 15, in order that juvenile labour may not compete with adult labour during the period of demobilisation and the readjustment of industry to peace conditions.

The annual meeting of the shareholders of Messrs. Bell Brothers, Limited, was held at Middlesbrough last Tuesday. Sir Hugh Bell, who presided, said that during the past year they succeeded in making 20,000 tons more pig-iron than in 1916, the total output reaching 334,033 tons. On the other hand, whilst their output of coal was nearly 1,000,000 tons in the previous year, it was only 769,768 tons in 1917. Conditions in the coal trade were so complicated that it was doubtful whether any man in the kingdom, including the Coal Controller, could give the least idea of the way in which coal was now got in England. One thing was certain, that there was not nearly so much coal as was wanted, a circumstance of which the country would become painfully aware before the year was out. They succeeded in increasing their output of ironstone by 211,500 tons. In 1917 they paid in wages, including compensation, war allowances, and national insurance, 819,687*l.*, and for salaries 27,858*l.* Altogether, their disbursements were nearly 1,500,000*l.* The average weekly wage was 50*s.*, against 42*s.* in 1916. There was little ground for complaint as to lost work at the collieries. Out of 221,226 shifts worked, 4,774 were lost through neglect, and 9,364 through illness. He wished he could speak in the same terms in regard to the ironstone miners, where, out of 150,553 shifts worked, 14,012 were lost through neglect, and 11,482 through illness. The loss in the mines through neglect was estimated to amount to 93,673 tons of stone, equal to 30,000 tons of iron. The company, added Sir Hugh, had acquired the Burley Ironstone Quarry, in Northamptonshire, which contains 6,000,000 tons to 8,000,000 tons of ironstone. This represented about 2,500,000 tons of iron. They had also added to their coal resources by upwards of 750,000 tons.

THE "EXCELSUS" PROPELLER-SHAPING MACHINE.

IN our issue of June 14 we published an account of a propeller-shaping machine brought out by Messrs. A. Ransome and Co., Limited, of Newark-on-Trent, in conjunction with Mr. J. J. Kerr, of Lincoln. At that time it was not deemed desirable to publish engravings, but that restriction has now been removed, and we are able to reproduce photographic illustrations of the machine.

It will be seen at a glance that the machine is a copying lathe modified to suit such an article as a propeller. It is shown at work on a two-bladed screw, but its capabilities would have been better demonstrated if a four-bladed screw had been available at the time the photographs were taken. The rough propeller is held and driven by its boss (Figs. 1 and 2) while the tip of the blade under operation is guided and steadied by the back centre carried by the poppet head. It is a little difficult to follow the construction of the driving head in the photographs, but on close inspection of Fig. 2 it will be seen that what would be called the faceplate in an ordinary lathe has a wide aperture cut through it, and two bosses formed on its back to carry the propeller. On the edge of the faceplate is a wide flange which constitutes a journal and runs in a bearing in the headstock. On this flange there are also gear teeth by which it is driven from the pulleys at the end of the machine. The model is also geared to the same shaft, so that model and blank both rotate together at the same angular speed.

Down the centre of the bed there runs a feed screw which carries the cutter along the bed as it gradually shapes the propeller blade. The screw also serves as a guide, support and pivot for the swinging angle bracket which carries both the cutter block and the copying roller, these two being each 10½ in. in diameter. As the model rotates the angle bracket tilts backwards and forwards on the exterior of the screw threads, while at the same time it is fed along the screw by a nut geared to the cutter block. If the belt driving the block should break the feed ceases at the same time.

It will be seen that the machine will deal with two or four-bladed propellers up to a large size, and that it will turn them out with rapidity and with fidelity to the model.

HEAVY AMERICAN GOODS WAGONS.—Last year, states *The Iron Age*, a new 85-ton hopper car was constructed by the Pennsylvania Railroad, at its Altoona shops. With the 10 per cent. allowed above capacity, this car will carry 93·5 tons, and this really means that the 100-ton car will soon appear. The records show that the present average car load throughout the United States is only 22·5 tons. The Norfolk and Western has over 1,700 steel gondola cars, with six-wheel trucks, having a 200,000-lb. capacity, in regular service and giving satisfactory results. The Virginian Railway has four 120-ton steel gondola cars, built during the last year for experimental purposes. The 13 shipping companies of the United States Steel Corporation have conducted a vigorous campaign for the heavier loading of cars, and during the year 1917 the average car-load of these companies was 88,300 lb. per car.

THE LATE MR. ISAAC BEARDMORE.—We regret to have to record the death, which occurred at his residence, Lymington Lodge, Bothwell, on Wednesday, the 3rd inst., of Mr. Isaac Beardmore. Mr. Beardmore was 82 years of age, and was born at Deptford. For a long period he was associated with the management of Parkhead Forge, Glasgow. Fifty years ago he became a partner with his brother, the late Mr. William Beardmore, father of Sir William Beardmore, Bart., the present head of the firm. He severed his connection with the steel trade in the late 'eighties of last century, but he is remembered by many as one of the early makers of acid open-hearth steel in Scotland; in 1880 he was instrumental in converting Parkhead Forge from an iron into a steel works. Mr. William Beardmore died in the year 1877, and Mr. Isaac Beardmore continued to act as senior partner until 1886, when the present chairman of the company, Sir William, took over the control of the business.

COAL PRICES.—The Board of Trade have made an Order providing for an increase of 1*s.* 6*d.* per ton in the price of all coal despatched from the colliery for consumption in the United Kingdom on and after Monday, the 8th inst., to meet the cost of the increased war wage recently granted to the miners. The prices of coal for shipment for export and as bunkers are increased by 2*s.* per ton in the case of all vessels the loading of which is commenced on or after the 8th inst., the 2*s.* being made up of 1*s.* 6*d.* to meet the cost of the war wage and 6*d.* to meet increased dock, &c., charges. The Board of Trade have also issued directions under which they assume responsibility for the payment of the war wage as from June 30, and, to provide funds for so doing, are to be credited by the collieries with 4*s.* per ton on all coal disposed of on and after that date. This ensures that the whole of the increases in prices which have been granted to meet the cost of the war wage shall be specifically applied to that purpose.

THE "EXCELSUS" PROPELLER-SHAPING MACHINE.

CONSTRUCTED BY MESSRS. A. RANSOME & CO., LTD., ENGINEERS, NEWARK-ON-TRENT.

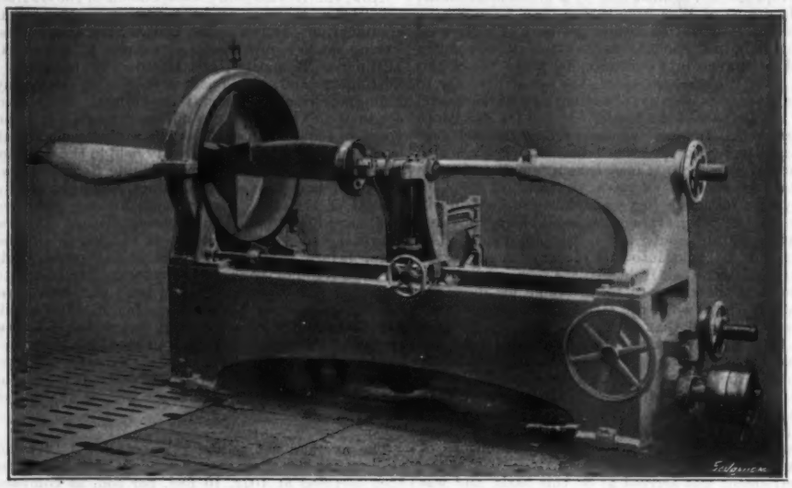


FIG. 1.

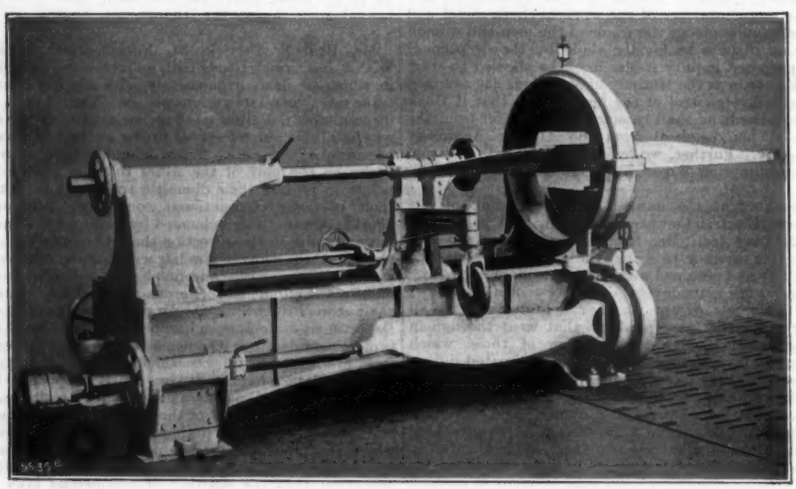


FIG. 2.

RECONSTRUCTION IN INDUSTRY.

WE are informed that the formation of Joint Industrial Councils on the lines of the Whitley Report is steadily progressing. Councils in the pottery and building industries are already at work, and during the present month the following newly-formed councils will hold their first meetings: The heavy chemical trade; gold, silver and allied trades; the rubber industry; match manufacture; the silk industry.

The dates of the meetings have been fixed in the case of the Rubber Council which takes place on July 16, Gold, Silver and Allied Trades Council on July 20, the Matches Industrial Council on July 30, and the Silk Industrial Council, which takes place on either July 25 or 30.

In the following industries provisional committees have already drafted constitutions of proposed Industrial Councils, which have been sent out to the various associations concerned for their approval: Baking; cable-making; commercial road transport; electrical contracting; furniture making; leather goods and belting; vehicle building.

A constitution for the printing industry has been drafted and will shortly be sent out for approval to the associations concerned. When these constitutions have been approved the first meetings of the newly-formed councils will be arranged with as little delay as possible.

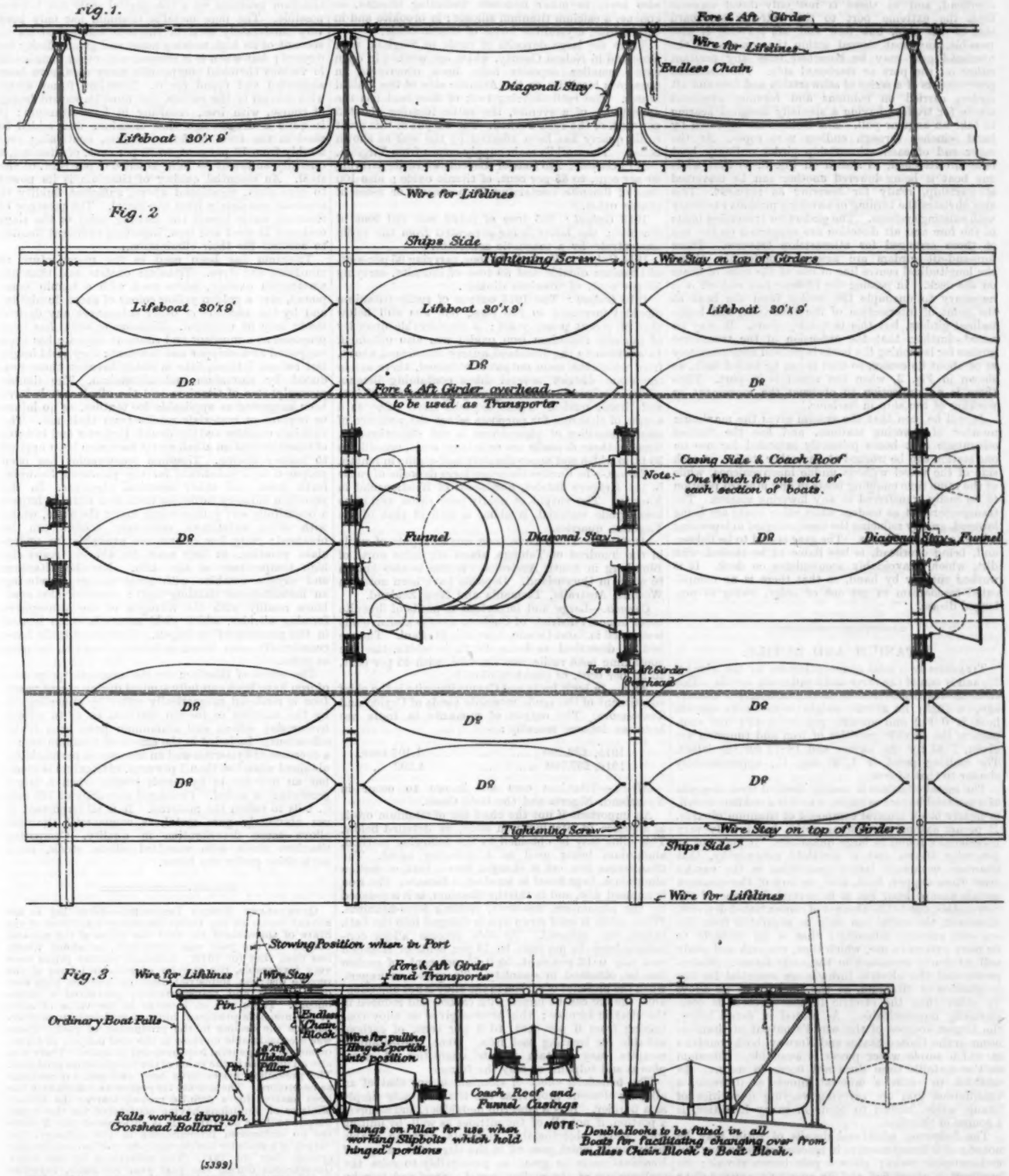
In the following industries preliminary conferences as to the formation of Industrial Councils have taken place and proposals to proceed with the drafting of constitutions have been approved: Bobbin manufacture; boot and shoe manufacture; electricity power and supply; roller engraving; woollen and worsted industry.

In some 20 other industries the question of the formation of Joint Industrial Councils is being given careful consideration, and in a number of cases proposals to summon joint conferences of employers' association representatives and trade union representatives have been approved.

There are many of the nation's industries, of course, in which the organisation on the side either of the employers or of the workers is not sufficiently representative as yet to admit of the formation of Joint Industrial Councils at once. In these industries the "Whitley idea" is being carried out by the formation of temporary bodies which are termed Interim Industrial Reconstruction Committees. They will deal with the many urgent problems attached to the re-establishment of their representative industries on a peace basis and in addition will improve the organisation of their trades where it is at present unrepresentative. Later it is hoped they will be in a position to pass from their temporary nature and become full Joint Industrial Councils. Towards the formation of these temporary bodies the Ministry of Reconstruction has already made considerable progress and committees have already been established in some 20 trades and industries. Fuller details of progress in this matter will, we are informed, be available shortly.

TRADING WITH THE ENEMY ACT.—The Controller of the Foreign Trade Department has issued a new list (No. 58) of additions to the Statutory List of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade. Copies of this list can be obtained at a trifling cost from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

THE ROSS-ANDERSON LIFEBOAT TRANSPORTING AND LOWERING GEAR.



THE subject of stowing and lowering lifeboats on merchant ships is one of almost perennial interest, and at no time is it of greater importance than at present. The Government requirements compel the carrying of lifeboats and rafts to accommodate the whole of the passengers and crew which may be carried on any ship, and, as a rule, difficulty is experienced in stowing these in vessels in such a position as to enable them to be easily transferred to the davits or other lowering gear. Many solutions have been applied, notably by fitting of turning-out gear on the ordinary types of davits, and having some arrangement for transporting the boats from inboard positions to the davits by gear rigged on deck; by fitting davits of the quadrant type arranged in multiple numbers across the deck, and each capable of lifting boats in two positions in an athwartship direction; and by other mechanical means, such as cranes. These devices have been open to criticism. The first, where the transporting gear is placed on deck, involved difficulties due to such obstructions as skylights, ventilators, coach roofs, &c., these being in the centre of the ship, so that the lifeboats could only be launched on the side of the ship on which they were stowed on deck. In the case of a ship with a heavy list to the opposite side, this increased the difficulty of launching the boats. With davits of the quadrant type the difficulty was to obtain deck space for the inboard set of davits.

We illustrate above the Ross-Anderson lifeboat transporter devised by Mr. Alexander Ross and

Mr. John Anderson, members of the staff of Scotts' Shipbuilding and Engineering Company, Limited, Greenock. In this case the transporting gear is entirely overhead, and as there is not only direct traverse from the extreme port to the extreme starboard side of the ship, but fore and aft traverse is also possible, any boat stowed within the compass of the overhead gear may be launched from any position either on the port or starboard side. The overhead gear consists of a series of athwartship and fore-and-aft girders carried on columns and forming overhead tracks for trolleys having a specially designed bearing to take an angular pull. The trolleys are operated by hand winches through endless wire ropes. At the outer end of each athwartship girder ordinary boat falls are attached, as shown on Fig. 3, so that while one boat is being lowered another can be traversed athwartship, ready for lowering as required. This also obviates the turning or swinging motions necessary with existing systems. The girders for traversing boats in the fore and aft direction are supported on the top of those arranged for athwartship traverse. These fore-and-aft girders are arranged preferably above the longitudinal centre line of one of the rows of boats on the deck. In passing the lifeboat fore and aft it is necessary to uncouple the trolley from the boat at the point of intersection of the transverse and longitudinal girders, but this is quickly done. It may be noted, further, that the extension of the transverse girders for launching the boats is pivoted approximately at or about its centre, so that it can be folded back, as shown in Fig. 3, when the vessel is in port. Thus there is no projection to obstruct the movement or working of the ship in harbour.

It will be seen that the system gives the maximum number of lowering stations, and has the further advantage that boats primarily intended for use on one station can be worked at any other station on each side of the vessel without undue inconvenience, while at the same time enabling boats in any inboard position to be easily transferred to any lowering station. The transporters act as feeders while other boats are being lowered, greatly reducing the time occupied in launching a large number of boats. The gear is said to be lighter, and, being overhead, is less liable to be choked with dirt, which unavoidably accumulates on deck. It is worked entirely by hand, so that there is no complicated mechanism to get out of order, owing to prolonged disuse.

TITANIUM AND RUTILE.

TITANIUM is a solid element known by the symbol Ti, and is one of the rarer and less known metals. This element was discovered by Berzelius nearly a century ago, in 1825; its atomic weight is 48·1; its specific heat is 0·112 and specific gravity 5·17; for comparison the specific gravities of iron and tungsten are given, 7·85 for the former and 18·77 for the latter. The melting point is 1,795 deg. C., approximately similar to that of iron.

The metal titanium is mainly derived from deposits of a material known as rutile, which is a reddish-brown, or nearly black mineral composed of titanium dioxide. It occurs extensively among rocks, but is only very occasionally found in large quantities. It may not be generally known and is certainly noteworthy, that titanium occurs in larger quantities in the earth's crust than copper, lead, zinc, or any of the common metals except iron, but it is nevertheless one of the rare metals, due to the absence of concentrated deposits. Moreover, the metal can only be separated from the ore with extreme difficulty; that is an obstacle to its more extensive use, which time, research and study will no doubt overcome in the early future. Water-power and the electric furnace are essential for the production of titanium, as the smelting of its alloys by other than the electric furnace process is commercially impracticable. As stated in detail below, the largest sources of the world's output of titanium occur in the United States and Norway, both countries in which ample water power is available. Titanium in the metallic form does not occur in nature. In addition to rutile a mineral known as ilmenite, a titaniferous iron ore carrying varying quantities of titanic oxide, known to occur in many localities, is a source of titanium.

The following additional details of rutile may be noted: it is found massive in igneous, sedimentary and metamorphic rocks; gives a pale brown streak; its hardness is about 6·5 and its specific gravity 4·2 to 4·3, somewhat less than that of titanium. The mineral frequently contain as much as 98 per cent. to 99 per cent. of titanic oxide and from 1 per cent. to 2 per cent. of ferric oxide. Ilmenite, or titaniferous iron ore, is an iron-black mineral occurring massive, or in the form of thin plates, or grains; its hardness is 5 to 6; specific gravity 4·5 to 5, and lustre submetallic. The fracture is conchoidal and its streak brownish-red to black. The composition of ilmenite is represented by the formula FeO,TiO_2, corresponding to 47·3 per cent. of ferrous oxide, and 52·7 per cent. of titanic oxide. Considerable percentages of titanium also occur in other minerals, including titanite, or sphene, a calcium titanium silicate; in brookite and in octahedrite, crystalline forms of titanic oxide.

There are large deposits of rutile in Virginia, near Roseland in Nelson County, which are worked in open cuts; smaller deposits have been discovered in numerous localities on the Atlantic side of the United States. The rutile-bearing rock of Roseland has the appearance of a syenite, the rutile forming about 5 per cent. of the rock worked. The output of this great rutile quarry has been affected by the war as shown below. The world's main supply comes from Virginia.

1912 *Output:* 275 tons of concentrate rutile carrying 80 per cent. to 85 per cent. of titanic oxide; also 100 tons of ilmenite containing 94 per cent. or more of titanic oxide.

1913 *Output:* 305 tons of rutile and 250 tons of ilmenite; the latter being separated from the rutile concentrate by a magnetic separator.

1914 *Output:* Was only 94 tons, carrying 95 per cent. of titanium dioxide and 89 tons of ilmenite, carrying 55 per cent. of titanium dioxide.

1915 *Output:* The 1915 output of rutile (titanium dioxide) increased to 250 tons, but was still below that of recent peace years; a considerable quantity of ilmenite (titanium iron oxide) was also obtained. In addition to the Roseland quarry mentioned above, from which the main output is obtained, there are in the same district several dikes containing ilmeno-rutile, a mineral containing varying amounts of iron and titanic oxides. These deposits have value as a source of titanium for purposes where the presence of small quantities of phosphorus is not objectionable. Some of these deposits are on a large scale, one dike is 30 ft. in width and approximately half-a-mile in length.

Europe.—In Europe there are large deposits of rutile in the Kragero district, north-east of Kristiansund in Norway. The output of nearly pure rutile, and some lower-grade material, is about a fifth of that of the Virginian quarries.

Australia.—There have been small outputs of rutile in the hundred of Talunga, about six miles north of Blumberg in South Australia. Rutile is also known to occur in Queensland. Deposits have been noted in Western Australia, Tasmania and New Zealand.

Canada.—Large and important deposits of ilmenite occur in many districts of Quebec; a very extensive one is situated in Saint Urbain, near Baie St. Paul. The ore bed is described as being 90 ft. in width, the ore containing both rutile and ilmenite, with 45 per cent. to 50 per cent. of titanium dioxide.

Asia.—In both India and Ceylon ilmenite is the chief constituent of the crude monazite sands of Ceylon and Travancore. The output of monazite in India has been as follows recently:—

1915, £33.200	....	....	....	1,107 tons.
1916, £37.700	....	....	....	1,292 ,,

Africa.—Titanium ores are known to occur in Nyasaland, Nigeria and the Gold Coast.

An important if not the chief use of titanium ore is as a source of titanium-iron alloy, as detailed below. This alloy may be obtained by the following method, aluminium being used as a reducing agent. The titaniferous iron ore is charged into a bath of molten aluminium, kept fused in an electric furnace. The iron is reduced first, and in this the titanium, as it is reduced by the aluminium, dissolves, yielding ferro-titanium. When rutile is used scrap iron is charged into the bath before the mineral. By this process alloys containing from 10 per cent. to 75 per cent. of titanium and only 0·12 per cent. to 0·75 per cent. of carbon can be obtained in quantity. To quote an expert, when the presence of carbon in the alloy is not objectionable, the ore can be mixed with carbon and reduced in the electric furnace; this process gives an alloy containing from 6 per cent. to 8 per cent. of carbon, suitable for treating cast iron. Some ferro-titanium samples may contain minute quantities of phosphorus and sulphur, or only the former.

The beneficial effect of titanium is not that of an alloying element proper, as the titanium acts simply as a purifier. It is a powerful deoxidiser, and removes a portion, if not all, of the nitrides as well, by uniting with those objectionable elements, forming stable compounds, which pass off in the slag; the energy of combination is so great as perceptibly to raise the temperature of the molten metal. Steel and iron by this treatment acquire freedom from blow-holes and other imperfections, also greater strength, elasticity and wearing properties. Moreover titanium prevents brittleness, hence the carbon content of, say, rails, may be materially increased and should be increased, if the full benefit of the titanium treatment is to be obtained.

So recently as some ten years or so ago titanium compounds were only used to a very limited extent; it is only since the development of the high temperature electric furnace and the discovery of considerable and workable deposits of rutile, that the manufacture of titanium products on a commercial scale has become possible. The pure metallic titanium has only been very moderately used in the arts and industries on account of its high melting point and great affinity for oxygen; but when it is alloyed with other metals and in various chemical compounds many uses have been suggested and found for it. Titanium forms alloys with several of the metals, the most important being, of course, with iron, resulting in ferro-titanium; it is quite a decade ago that titanium was added to steel in the form of ferro-titanium, containing preferably from 10 per cent. to 20 per cent. of titanium, a quantity sufficient to form about 0·1 per cent. of the steel. An essential quality of titanium is its power to give slags, mentioned above, sufficient fluidity to separate completely from the metal. The presence of titanium oxide lowers the melting point of the slags occluded in steel and iron, inparting sufficient fluidity to account for their elimination..

Titanium has been used in the manufacture of mordants and dyes. Titanium oxalate and titanium ammonium oxalate, when used with a tannin compound, give a golden yellow colour of great durability, and by the addition of other substances any desired shade may be obtained. Titanous chloride has been proposed as a mordant and titanous sulphate has been suggested as a stripper and mordant; they yield bright fast colours intermediate in shade between those produced by chromium and aluminium. The double pyrosulphates of titanium and the alkali metals have been suggested as applicable for textiles, as no injury to texture or materials results from their use. The titanium oxalates and the double tartrates and lactates of titanium and an alkali metal have also been applied to leather dyeing. Titanium ferrocyanide has been proposed as a substitute for the poisonous Schweinfurth green and other arsenical pigments. In the porcelain industry rutile has been used alone to impart a beautifully soft yellow colour under the glaze, whilst with other substances secondary colours can be obtained; very few colours are available for underglaze painting, as they must be able to resist the high temperature of the kiln. Metallic titanium and oxygen combine with great energy, producing an instantaneous dazzling light; titanium also combines readily with the nitrogen of the atmosphere forming nitrides, which yield ammonia when heated in the presence of hydrogen. Crystals of rutile have occasionally been found sufficiently clear to be used as gems.

The effect of titanium on the magnetic properties of iron have been carefully studied during recent years. Iron is rendered magnetically softer by annealing, or by the addition of foreign material so as to reduce hysteresis; silicon and aluminium have been found efficacious. Included in the effects of titanium are:—a decrease of hysteresis and an increase in permeability obtained when less than 1 per cent. of titanium is used; but an increase in hysteresis results when a larger percentage is added. Prolonged annealing at 760 deg. C. fails to soften the material. It is all important to use absolutely pure metal, as commercial titanium alloys cause deterioration in quality. Comparing titanium steels with standard silicon steels, some authorities prefer the latter.

QUEENSLAND MINING INDUSTRY.—According to the annual report of the Under Secretary for Mines of the State of Queensland for 1917 the value of the mineral output for the year was 3,905,830*l.*, or about 7,800*l.* less than that for 1916. Although market prices were very favourable, the scarcity of suitable labour in the remote districts, industrial disputes, and the high cost of materials and transportation, prevented a larger output. There was an increase in the value of some of the minerals produced, but not sufficient to counterbalance the decline in the production of gold. There was a considerable increase in the coal output, in consequence of the general improvement in trade. There was also an increase in the value of the molybdenite produced. The prevailing prices have been obtained for wolfram as heretofore. The market for copper at a fixed rate has been assured for a definite period, due to the British Minister of Munitions having contracted for the entire output to June 30, 1918. It is anticipated that if there are no unforeseen interruptions in the industry, the output of metals for the current year will be considerably greater than for 1917. The collections by the State Government during the past year for rents, royalties and various kinds of fees, amounted to 28,000*l.*, an increase of about 2,200*l.* over the amount for 1916. The total expenditures of the department amounted to 40,000*l.* Among the items were: Deep sinking, 17,440*l.*; aid for prospecting, 6,600*l.*; improvement of roads to mineral deposits, 2,227*l.*; advances under the mining machinery act, 945*l.*; and purchase of boring plant and boring for oil at Roma, 3,450*l.* Sixteen new mines were opened during the year, and eight that had been closed down for extended periods were reopened, while 12 discontinued operations.

ENGINEERING MATERIALS.

We have been able to keep pace with the great demand for materials occasioned by war work, however difficult and costly the effort. Home production has largely increased, and the United States furnaces and mills have rendered invaluable service. The following tables give the import supply over a series of eight years—roughly, four years of war and four years before the war. We may recall that 1910 was a good average year, marking full recovery from the depression of 1907–8. The year 1913 was a prosperous year, and as the last complete pre-war year will always be a kind of statistical mile-stone. In the first table the pig-iron figures give the total of the four classes—viz., basic, forge and foundry, hematite and the class including spiegeleisen, iron-manganese and iron-silicon. The basic was increasing during the last year, 1917, while the others decreased. The manufactured iron and steel includes bars, rods, angles, plates, rails and sections generally, as well as ingots, billets and castings in the rough.

Iron and Steel Materials.—Imports in Tons.

Year.	Pig Iron.	Manufactured.
1910	172,456	1,194,887
1913	217,766	2,002,600
1914	223,516	1,394,499
1915	194,422	982,918
1916	157,544	615,302
1917	155,173	341,643

It is very little use giving the values or prices, because they are of doubtful comparative interest and are really artificial values. The imports of the important non-ferrous metals, apart from ores, for the same period are given in the following table:—

Non-Ferrous Metal Materials.—Imports in Tons.

Year.	Tin.	Copper.	Zinc.	Lead.
1910	46,285	159,791	121,117	218,936
1913	45,682	150,458	145,004	204,136
1914	40,961	196,459	115,859	224,916
1915	38,896	218,672	74,522	255,977
1916	33,646	155,251	53,327	158,373
1917	27,143	171,019	76,105	147,124

The tin comes in blocks, ingots, bars and slabs; the zinc in crude form in cakes; the lead in pig and sheet. There are imports of articles manufactured of these metals in addition, but not included in the above figures. Considered as trade returns, the figures as a whole would appear bad; but as war returns, with all the circumstances allowed for, they must be regarded as highly satisfactory. Figures of iron and steel production were given in our columns, vol. cv, page 704.

BOILER EXPLOSION AT RETFORD.

A FORMAL investigation under the Boiler Explosions Acts 1882 and 1890, has been held at the Court House, Retford, with regard to a fatal boiler explosion which occurred on February 27 last, at Danes Hill Farm, Retford, the tenant of the farm and the owner of the boiler being Mr. George Agars Walker. The Commissioners were Mr. Archibald B. Bence-Jones barrister-at-law, and Mr. A. J. Maginnis, M.Inst.C.E., M.I.Mar.E., consulting engineer. The investigation was conducted on behalf of the Board of Trade by Mr. George C. Vaux. Mr. Walker was made a party to the inquiry.

The explosion resulted in the death of Henry Himsworth, who was the man in charge of the boiler at the time. At the coroner's inquest the jury returned as their verdict that the death was accidental and that "the employer, Mr. G. A. Walker, was guilty of gross negligence for not having the boiler periodically examined by a competent man, seeing that the boiler had been in use over fifty years and it was over twenty years since it was last repaired." They also added a rider "that all owners of boilers ought to be legally bound to have them examined every twelve months by an official examiner."

In opening the proceedings on behalf of the Board of Trade, Mr. Vaux explained that the inquiry was taken under Section 6 of the Boiler Explosions Act, 1882. The boiler in question was of the single-flued or Cornish type, 12 ft. long by 4 ft. in diameter. The mountings consisted of two safety valves, each 3 in. in diameter, one being a Salter spring balance and the other a lever-weight valve loaded to blow off at 45 lb. pressure to the square inch. There was a steam-pressure gauge, graduated to 145 lb., fixed on the front of the dome; also a glass water gauge, two check valves, and a blow-off valve, a cast-iron steam pipe, 1¼ in. in diameter from the top of the steam dome to the engine, which was used to drive a threshing and grinding machine, and another 1-in. cock to a potato steaming pan.

The boiler was set in brickwork in a building attached to the engine-house, and was below the ground level. The name of the maker, Mr. Vaux said, had not been ascertained, but in 1884 the boiler was taken over by Mr. Walker, with the farm, from his father's executors. The boiler was then on the farm, and had been working there for some years previously. The farm was 784 acres in extent, and when he took possession Mr. Walker put all the machinery, including the boiler and another portable engine, in charge of Henry Himsworth, who was a farm blacksmith, and he attended to and worked it up to the morning of the explosion, when he was unfortunately killed. Some twenty-seven years ago, about 1891, the boiler was sent away to a firm of engineers to be overhauled, and a new end plate, together with several belts of plating, was applied, but the name of the firm had not been traced. The boiler was not insured, and from the time these repairs were carried out it had never been inspected by any competent person. It was used for supplying steam to a grinding and threshing machine about one day a week, from the latter end of September to the middle of March each year, and for the remainder of the time it remained idle, except for a few days in the summer when corn had to be ground. The pressure of steam required for the grinding of corn was about 20 lb., and for threshing not above 45 lb., and the safety valve should have blown off at or about 45 lb. There was no record of any trouble with the boiler until towards the end of last year, when a leakage occurred at the furnace end, and in January, 1918, by Mr. Walker's orders, or with his knowledge, Himsworth, the blacksmith, fitted a rough bolted patch round the mud hole at the bottom of the front end plate. This repair took several days to execute, and the boiler seemed to have been used once afterwards before the explosion occurred. On February 27, about 6.15 a.m., the fire was lighted by a man named Richardson, and Himsworth arrived later and took charge. About 8.30 a.m. steam had been raised to 40 lb. per square inch, and the engine was set to work threshing wheat, with Himsworth in charge. Between this time and 10.40 a.m. Richardson went into the boiler-house two or three times, but noticed nothing wrong with the boiler. He passed through to obtain some oil and noticed Himsworth going down some steps to the stokehole; he got the oil, and was coming out when the boiler exploded and he was blown across the yard, but not severely hurt. Himsworth was so seriously injured that he died the same day. The boiler-house was demolished.

The first witness called was Mr. Walker, the owner, who deposed to taking over the farm from his father's executors in 1884; previous to that he had a farm north of Doncaster for some years, and also a blacksmith's business at Ranskill, where he engaged Himsworth, who had been brought up as a blacksmith, and there they executed repairs to agricultural tools, but not, of course, to boilers. When he took the Danes Hill Farm he had no evidence as to how long the boiler had been there prior to 1884. In 1891 the boiler was taken out and sent to Messrs. Marshall's works at Gainsborough, and some repairs were then effected. Himsworth was taught to drive the boiler in 1892, and the safety valve was then set at 45 lb., which was sufficient to drive the engine. He (witness) had found out since the explosion that the boiler had been patched, but he was not aware of this previously. Himsworth took over the duty of attending to the boiler in 1892, and he considered him to be a capable man. A week or two before the explosion, Himsworth made a complaint about the boiler, and asked to be allowed to put a plate on near the mud hole. The boiler had been used regularly from 1892 to the end of 1917, and was looked after by Himsworth. Witness had often seen the safety valve, fixed outside the building, blowing off. Himsworth put a plate on the boiler, and witness gave him half-a-sovereign because he had made such a good job of it. It was used twice after being repaired before the explosion occurred. It had never been inspected or insured by an insurance company, and witness personally had never seen anything wrong with the boiler, though he now knew that the plates had been corroded by dampness under the brickwork. To have detected the corrosion they would have had to take some bricks out or to have lifted the boiler out of its bed. Witness viewed it as far as he possibly could, but relied on Himsworth, and thought he would be sure to tell him as soon as anything went wrong. In January last he employed a man from Retford to go inside the boiler and clean it out, and to assist in fixing the fusible plug which had blown out. The man who cleaned the flues never reported that any water or dampness had been noticed under the brickwork, and it had never been suggested to him that he should have the boiler insured.

George Richardson, foreman at Danes Hill Farm, said that he had been working there for about thirty-four years, and remembered the boiler being sent away to be repaired about twenty years ago. He never heard Himsworth complain about the boiler. He was in the boiler-house on the morning of the explosion, and saw that the steam pressure was 45 lb. He had never noticed anything wrong with the boiler.

Mr. Henry F. Kidd, surveyor to the Board of Trade, Hull, said he was appointed to hold a preliminary inquiry into the case, and went to Danes Hill Farm and inspected the boiler after the explosion. He found that the plates resting on the brickwork were so wasted away by corrosion that there was practically no boiler plate left at that part. The explosion lifted the boiler, and threw it over on its side. The cause of the explosion was simply the wasting of the plate by the corrosion as stated. He had been unable to ascertain the name of the maker. Boilers fixed in brickwork on farms were liable to corrode and waste where the plates rested on the seatings. All such boilers should be regularly inspected by competent persons.

The Commissioners then went to Danes Hill Farm and made an inspection of the exploded boiler, &c.

The following day, the Court resumed, and the Commissioner, Mr. Bence-Jones, delivered judgment. He dealt fully with the history of the boiler, and said that it seemed strange that it did not occur to Mr. Walker to employ an expert to examine the boiler from time to time so as to ascertain its precise condition. It seemed probable, however, that the confidence he had in Himsworth blinded him to the necessity of skilled and minute inspection. Were it not for this confidence in a reliable servant, the Commissioners would have felt compelled to express a strong opinion on the laxity Mr. Walker had displayed. The explosion was, beyond all question, due to the extremely wasted condition of the plates which were resting on the brickwork seating, and thus rendered them unfit to sustain any pressure of steam. The position of the wasted plates was such as would easily have been found out by an expert, as experience proved that the portion of the shell in contact with the brickwork was the part most liable to wasting by corrosion. The lesson, the Commissioner said, should not be lost on those who were in the habit of using boilers on farms. In the mismanagement of a boiler the excuse that the owner was ignorant of what he ought to have done could not relieve him of responsibility. Mr. Kidd, a Board of Trade surveyor of long standing had, in his evidence, given it as his pronounced opinion that inspection by experts should be carried out on all farm boilers periodically.

Mr. Vaux then submitted to the court the following questions on which he asked their decision:—

1. What was the age of the boiler, and when was it set to work at the Danes Hill Farm?—The age was not known.

2. When did the boiler come into the possession of Mr. George Agars Walker? Under what conditions was it worked thereafter?—Satisfactory condition of steam purposes, but not as regards periodical inspection.

3. Was the boiler thoroughly examined and repaired by any competent person or persons after the year 1884? If so, when, and were any repairs then done, properly executed?—No; but in 1891 repairs to the shell plate were properly executed.

4. Was the boiler entrusted by Mr. George Agars Walker to a competent person?—Yes, as regards steam raising.

5. Was the boiler periodically inspected by a competent person or by competent persons?—No.

6. Was the repair effected to the boiler in January, 1918, sufficient and efficient?—Yes, so far as it went.

7. Did Mr. George Agars Walker take proper measures to ensure that the boiler was being worked under safe conditions?—No.

8. What was the cause of the explosion?—Extensive corrosion of the shell plate.

9. Is Mr. George Agars Walker to blame for the explosion? Should he pay any, and if so, what part of the costs of this formal investigation?—Yes, and he should pay the sum of 30*l.* towards the costs and expenses of this investigation.

In reply to the Commissioner, Mr. Vaux said that the costs would probably amount to 80*l.* or 100*l.*

The Commissioner considered that Mr. Walker did not take proper measures to ensure that the boiler was in safe condition, and therefore ordered him to pay the sum named to the Board of Trade. They thanked Mr. Vaux and Mr. Kidd for the assistance they had rendered to the court in the course of the inquiry, and expressed their sympathy with the relatives of the man Himsworth who had unfortunately lost his life in the explosion.

CRYSTALS OF BARIUM DISILICATE IN OPTICAL GLASS.—The crown-glass, rich in barium, coming from the melting furnace, not infrequently contains crystals, 3 mm. and more in length, colourless, but surrounded by a white opaque ring, very beautiful in appearance, though, of course, ruinous to the glass for optical purposes. Examining the crystals under the microscope and in other ways, N. L. Bowen (*Journal of the Washington Academy of Sciences*, May 4, 1918), finds that the crystals have a thickness of about 0·03 mm., and that the white rim consists of innumerable tiny crystals of the same substance, which have sprouted out in all directions, as is sometimes seen in the feldspar microlites with fibrous edges. The crystals form hexagonal plates, 3 mm. long, 2 mm. wide, of the orthorhombic system, and the refractive indices of the two rays are 1·613 and 1·595. The analogy of many potassium and barium compounds suggested the composition $BaSi_2O_5$, analogous to $K_2Si_2O_5$, and crystals of the same nature as those studied were obtained by fusing a mixture of the composition $BaSi_2O_5$ in the crucible. The artificial disilicate had, however, very slightly greater indices than those stated, namely, 1·617 and 1·598, and as the smaller, but similar crystals, sometimes forming by slow devitrification in barium crown, seem to have again smaller indices, the differences in refractive power are thought to be real, and not experimental errors. The barium disilicate, which melts at 1,426 deg. C., does not appear to have been studied before, though a silicate $BaO \cdot 2SiO_2$, was mentioned already by Gmelin-Kraut.

AMERICAN MANGANESE STANDARD ALLOYS.—The following statement, says *The Iron Age*, has been issued by Judge E. H. Gary, chairman of the Committee on Steel and Steel Products of the American Iron and Steel Institute: 'As the result of an investigation in the trade made by the sub-committee on ferro-alloys at the American Iron and Steel Institute, and of a meeting of the consumers of ferro-manganese and spiegeleisen held in Pittsburgh on May 7, pursuant to a call of the sub-committee on ferro-alloys, and, from other data available, the Committee on Steel and Steel Products recommends to the trade that a manganese content of 70 per cent. for ferro-manganese and 16 per cent. for spiegeleisen be adopted as standard, instead of the existing current standards of 78 per cent. to 82 per cent. in ferro-manganese, and 19 per cent. to 21 per cent., or higher, in spiegeleisen; that deliveries of material of the new recommended standard be accepted as good deliveries on existing contracts, with proper adjustment of tonnage and price; and that no ferro-manganese or spiegeleisen be made hereafter of higher manganese content than as above recommended, except with the approval of this committee, which will consider any special requests from consumers who can show the necessity of a higher manganese content when submitted through the sub-committee on ferro-alloys. The above recommendations are made because of the necessity of the maximum possible conservation of shipping and the consequent need to utilise domestic ores to the greatest possible extent."

"ENGINEERING" ILLUSTRATED PATENT RECORD.

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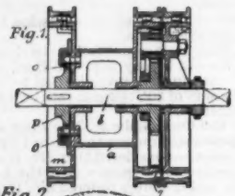
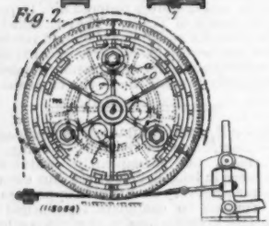
LIFTING AND HAULING APPLIANCES.

115,084. G. T. Macfarlane, Pinner. Winches. (2 *Figs.*) January 22, 1917.—To prevent the barrel, or each barrel, of a winch, according to this invention, when rotating in a lowering direction, acquiring too high a speed under the action of gravity, and reduce the necessity for employing the brake, the barrel, as by a free-wheel clutch or other device, is caused to directly, or indirectly, engage the driving shaft upon the rate of barrel rotation overtaking the rate of rotation of the driving shaft, the engine thereupon acting as a brake. The barrel *a* is driven in a hoisting direction through epicyclic gear. The end of the barrel remote from the epicyclic gear drums is formed in one with, or is fixed to, a drum *m* that is provided with a band brake and that has pivoted to it pawls *o* adapted to engage a ratchet

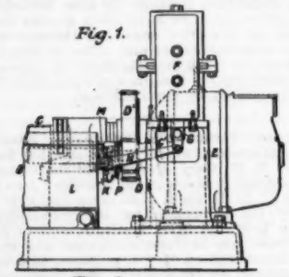


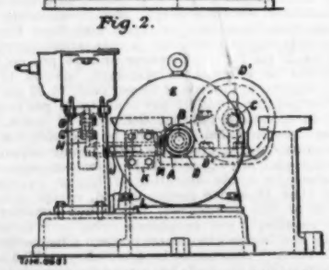


wheel *p* fixed to the driving shaft *b*. The arrangement is such that, during hoisting, when the barrel *a* and driving-shaft *b* rotate in opposite directions, the pawls *o* will slip idly over the ratchet wheel *p*, but during lowering, when the barrel *a* and driving shaft *b* rotate in the same direction, the pawls *o* will engage the teeth of the ratchet wheel *p* upon the rate of rotation of the drum *a* overtaking that of the driving shaft *b*, the engine, which in the case of an electric winch may be a shunt-wound motor, then acting as a brake. By these means the work usually taken by the ordinary brakes is, or can be, much reduced with corresponding prevention of overheating. The pawls may, if desired, be constructed and arranged so that they may be put out of action at will. (*Accepted May* 8, 1918.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

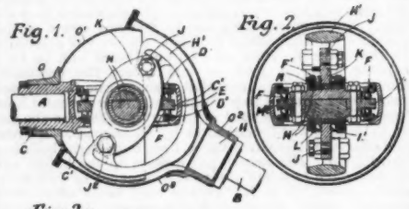
114,868. G. Stirk, E. Stirk, R. Stirk, and J. G. Stirk, Halifax. Electrically-Driven Machine Tools. (4 *Figs.*) March 19, 1917.—This invention relates to electrically-operated

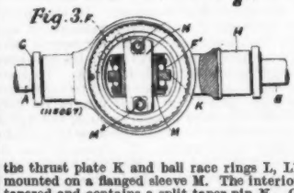




power traverses for machine tools, and consists in the operation by a solenoid plunger of lever mechanism linked with a clutch upon the shaft permanently coupled to the usual driving-feed gears at one end, to move said clutch into or out of engagement with a clutch member on a pinion keyed to the shaft of a motor at the other end. A is the clutch upon the feed-shaft B, which is coupled permanently to the usual driving-feed gears at one end, not shown, and to the lead screw C through gears D, D1 upon the engagement of said clutch with a clutch member P upon the pinion D. The pinion D meshing with wheel D1 on screw C is keyed on the shaft of motor E. The clutch A has a neck in which operates a fork secured to a lever M keyed upon a shaft J, mounted in a bearing K, bolted to the machine bed L. Also keyed upon the shaft J is a further lever H connected by link G1 with the plunger G of a solenoid F operating preferably in sequence with the motor E. Or the solenoid may operate in synchronism with the motor if desired. The plunger G, according to whether the solenoid is energised or de-energised, operates the aforesaid mechanism to move said clutch into or out of engagement with the member P. The method of operation is as follows. The feed shaft B is revolving slowly, and clutch A being engaged with member P, the screw C through the gears D, D1 is also revolving slowly for the feed or cutting operation. Upon closing the switch controlling the solenoid, the solenoid F becomes energised, and the plunger is lifted operating the levers H, M, shaft J, and fork to disengage the clutch A, so that upon moving the motor controller, the motor is supplied with current for transmitting the desired quick power traverse to the saddle by quickly revolving the screw C through the wheels D, D1. Upon the solenoid switch being again opened, the solenoid is de-energised, causing the plunger to drop, depressing one end of lever H, and reversing the movements of shaft J, lever M, and fork to move clutch A again into engagement with the member P for the next feed. This engagement occurs as soon as its teeth come opposite the corresponding spaces in member P which situation quickly arises as the shaft continues to slowly revolve. (*Accepted May* 1, 1918.)

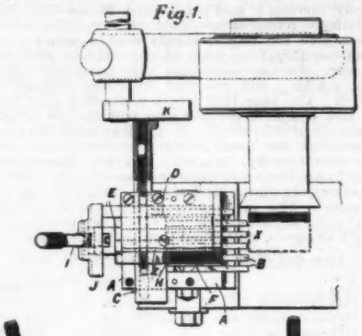
115,067. E. M. Munro, London. Universal Joints. (6 *Figs.*) April 20, 1917.—This invention has particular reference to an improved construction of the "Hooke" joint used for transmitting power through shafts which are out of alignment with each other. A joint, according to the present invention, is provided with two annular members having friction balls or rollers. The two shafts to be coupled by the joint are shown at A and B. To the shaft A is fitted a socket C, forming part of a housing C1 containing two outer ball race discs D, D1, and an inner thrust plate E. Balls F are placed between the members D, E and D1, E in the manner usual in a thrust ball-bearing. The shaft B is fitted with a socket H forming part of a fork H1 connected by bolts J to a plate K, which is the thrust plate of another ball being at right angles to the bearing attached to the shaft A. The balls F1 of this second ball bearing work between

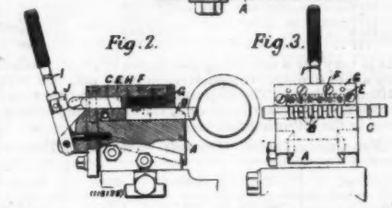




the thrust plate K and ball race rings L, L1. These rings are mounted on a flanged sleeve M. The interior of the sleeve M is tapered and contains a split taper pin N. One part of this pin is cut away at each end, leaving a central projecting portion which fits into a hole in the thrust plate E, and the two portions of the pin are bolted together by bolts M2 which pass through the plate E. Thus, the member E of the one ball bearing is rigidly connected to the outer members L, L1 of the other ball bearing, whilst the member K of that other ball bearing is connected through the fork H1 and socket H to the shaft B, and the outer members D, D1 of the first ball bearing are connected through the housing C1 and socket C to the shaft A. Upon the socket C is mounted a sleeve O to which a guard O1 is attached, and the socket H, attached to the shaft B, carries a similar sleeve O2, to which is attached a somewhat larger guard O3, the mouth of which is provided with a flexible washer formed so as to make a running joint over the guard O1. These two guards thus form an enclosing dust-tight case for the joint, whatever position the shafts A and B may assume. (*Accepted May* 8, 1918.)

115,138. A. Herbert, Whitchurch, and A. H. Lloyd, Earlsdon, Coventry. Multiple Tool-Holders. (5 *Figs.*) June 29, 1917.—This invention relates to multiple tool-holders for lathes, of the type providing a series of tools disposed side by side along a line which is parallel with the traversing movement of the holder, each arranged to cut more deeply than the preceding tool, several of the tools being arranged to operate at the same time and means being provided for automatically removing each tool successively out of the cutting position as the tool arrives at the end of the path allotted to it relatively to the work. According to this invention, such a tool holder is provided with a stepped former bar slidable in the tool-holder transversely of the tools, and adapted to hold the tools up to the work while they engage the former face of the bar and to release the tools when they pass a step in the bar. A is a tool holder, and tools B are free to slide longitudinally therein in separate slots. The tools B project from the holder A on one side, and when they are all in their forward position, each tool projects further than the one in front of it. The back ends of the tools butt against a sliding former bar C, which is stepped at D, and when the tools are against the former face of the bar, they are in their operative positions. Each tool is provided with a sliding detent E, which engages the tool to move back and forth with it, and is furnished with a spring F, which bears against a fixed part G of the tool-carrier at one end and against a pocket H in the detent E at the other end. The back ends of the detents E project at the back of the tool-holder, and a lever I is pivoted to the holder having a plate J, which extends across all of the detents in such position as to push them forward against their springs when desired. A stop K is provided for the stepped bar C, which stop is adjustably mounted so that as the holder A advances, the bar C is brought against it, and held stationary whilst the holder continues to advance. The operations of this device is as follows:—When the tool-holder A is started, all the tools B are in the operative position, and they come into operation on the work X, one behind the other until all of them may be at work at the same time. As the holder advances, the stepped bar C is brought against the aforesaid stop K, which is so adjusted that when the front tool arrives at the end of the traverse intended for it on the work, the bar C will have been arrested, and the holder advanced along it to

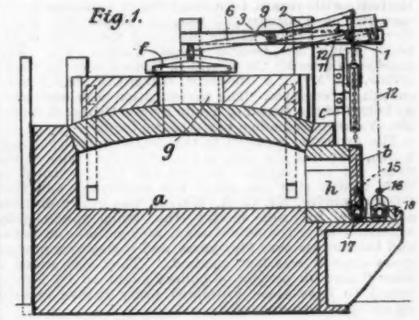


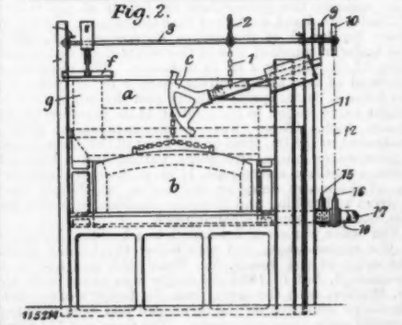


such position that the front tool is brought opposite the step D of the bar. As soon as it reaches this position, the spring-controlled detent E thrusts the tool back in its guideway in the carrier, and thus throws it out of operation; the same action takes place with each of the other tools in succession. (*Accepted May* 8, 1918.)

MINING, METALLURGY AND METAL-WORKING.

115,214. Burdons, Limited, W. M. Burdon, and M. M. Burdon, Bellshill. Gas Furnaces. (2 *Figs.*) January 17, 1918.—This invention relates to furnaces, which are heated by oil-gas or other gas under pressure. *a* is the furnace, *b* the fire door, *c* the usual counter-weighted lever for raising and lowering the fire door. *f* is the flue damper, and *g* the outlet flue from the furnace. Under this invention, the lever *c* is connected by means of a chain 1 to an arm 2 fixed on the shaft 3. On the shaft is the arm 6 connected to the damper *f* by means of the usual link. Now, when the fire door *b* is raised, the chain 1 and arm 2 will be pulled, and, consequently, the arm 6 and damper *f* raised so as to allow the gas within the furnace to escape freely, thereby





reducing the internal pressure, the reduction of pressure taking place immediately the door is elevated. In the furnace shown, two air pipes 17, 18 are adapted to blow blasts of air in front of the doorway *h* when the door *b* is raised, and these pipes are provided with gravity-action slide valves 15, 16, which may be operated by means of chains 11, 12, secured, respectively, to pulleys 9, 10, fixed on the shaft 3. When the fire door *b* is raised, the rotation of the shaft 3 will actuate the chains 11, 12, and the slide valves 15, 16; air will then pass from the pipes 17, 18, through the perforations therein at the front of the doorway. When the door *b* is lowered again, the slide valves 15, 16, automatically close again under the action of gravity. (*Accepted May* 8, 1918.)